# Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPT.
1010 EMPIRE BUILDING

MAY, 1945

MAY 26 1945

PITTSBURGH, PA.


# Birth of a Kaiser Ship

Production records of the Kaiser enterprises on the Pacific Coast have amazed industrial America... Pictured here is the Lewis 42 in. x 112 in. Three-High Finishing Mill, *part of the complete mill designed and erected by Lewis in the remarkable time of fourteen months*—engaged in turning out the vast tonnage of plate required for the great fleet of Kaiser-built ships.

*Also Manufacturers of* **LEWIS ROLLS**
for the iron, steel and non-ferrous industries

ARMY ★ NAVY ★

5 plants of Blaw-Knox Company have been awarded the Army-Navy "E" for excellence

**LEWIS FOUNDRY AND MACHINE**

DIVISION OF BLAW-KNOX COMPANY . . . PITTSBURGH, PA.

# UNITROL...The Motor Control that's tailored especially for Machine Design Needs

T. M. Reg. U. S. Pat. Off.

UNITROL is a better method of housing starters and other control elements for use in machine design. It consists of the motor control and the UNITROL door frame, an assembly with extreme flexibility of applic

UNITROL will fit anywhere in your machine housing and permits you to offer maximum convenience in use and accessibility for inspection and service.

The advantages of UNITROL-for-machine-design are numerous and notable:

- ✓ New freedom of design . . . control becomes virtually a part of the machine housing, offering utmost convenience to operator.
- ✓ Simplifies assembly . . . shortens time and labor in mounting and wiring.
- ✓ Streamlined . . . no bulky control elements *outside* the machine.
- ✓ Saves material costs . . . no *inside* mounting base, no *outside* enclosing case.
- ✓ Extreme accessibility for servicing and inspection . . . all parts are *out in the open.*

UNITROL, an outstanding contribution to the progress of Motor Control, beckons to every alert designer . . . points the way to *better machines* at *lower costs.* Act *NOW* to get this outstanding Motor Control for *your* machine by writing for complete information *TODAY.* CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

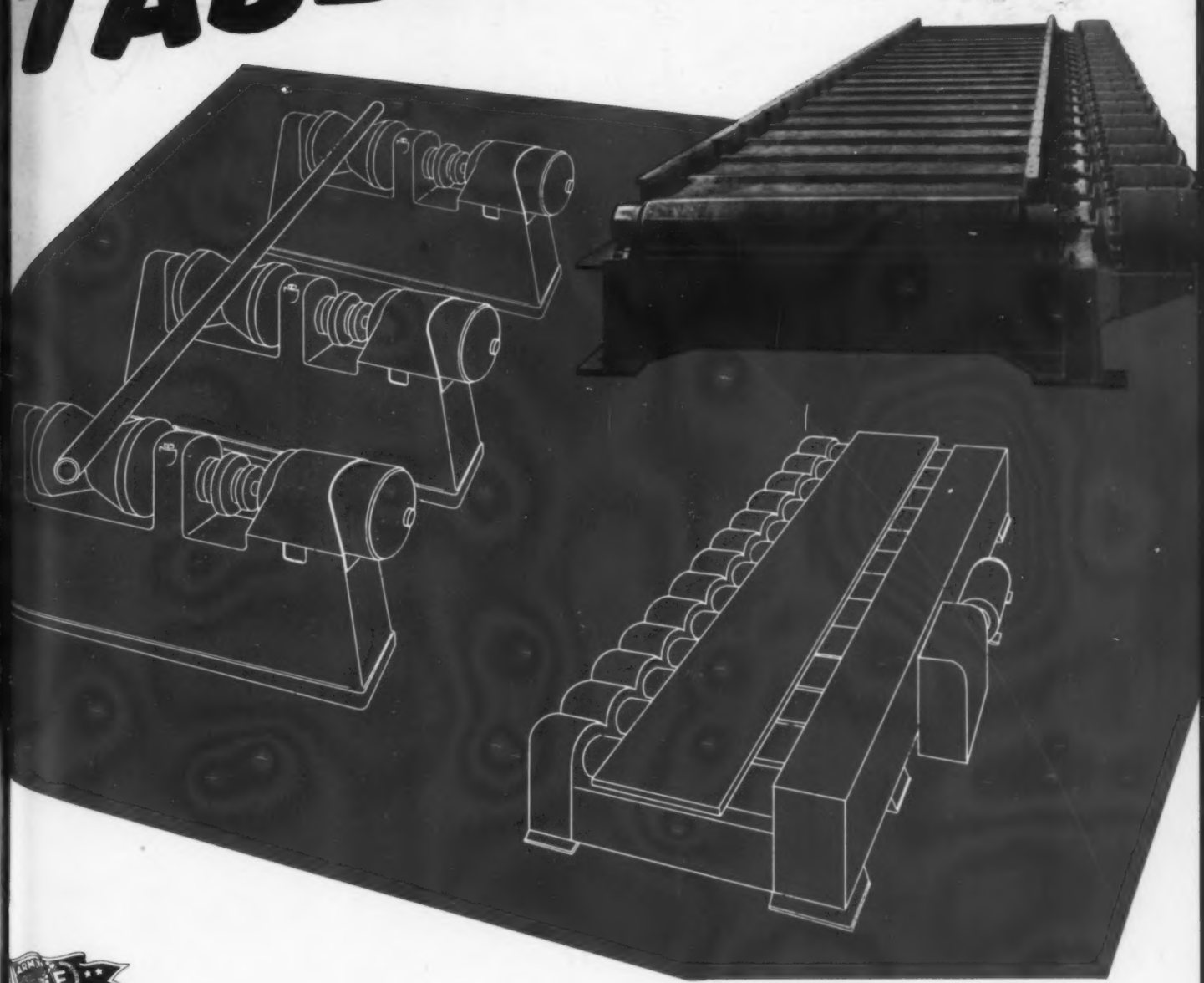
CUTLER-HAMMER
UNITROL
C-H

*Engineering excellence finds its greatest reward in the respect and confidence of those it serves*

ANOTHER PRODUCT OF AETNA•STANDARD

# MILL TABLES

Aetna-Standard manufactures many sizes and types of Mill Tables, including the following: Furnace Charging, complete with pusher; Furnace Delivery; Structural Tilting and Trailing; Bar Mill and Tube Mill Conveyor Tables.



Tables are equipped with anti-friction bearings, fully enclosed gear drives, centralized grease system.

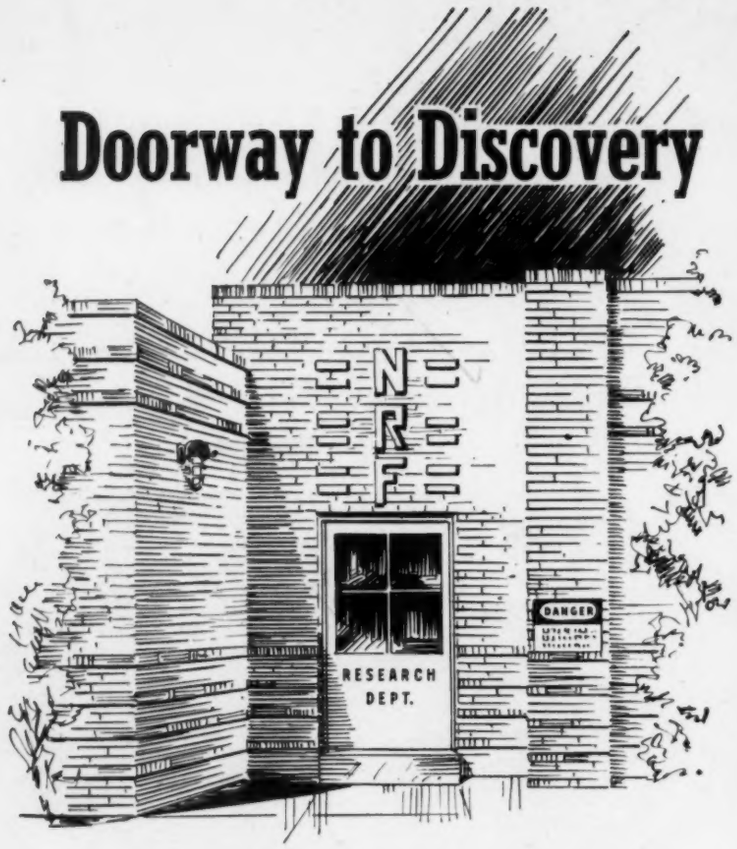
## THE AETNA•STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

*ASSOCIATED COMPANIES:*
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

# Doorway to Discovery

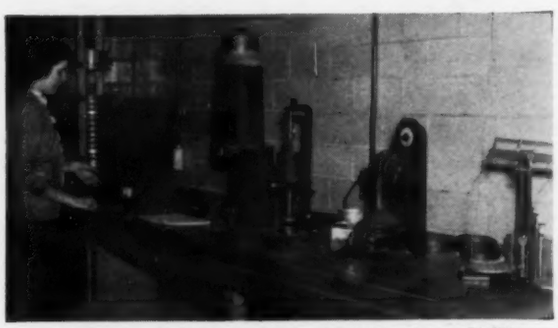



The wonders of tomorrow are being blueprinted today. Under the pressure of war, industrial developments are taking place that, in less strenuous times, might have required years to materialize. Already, technically speaking, our pre-Pearl Harbor world is an antiquity. The Steel World of tomorrow will benefit from the effects of this precedent shattering impulse.

The research department at The National Roll & Foundry Company is thinking ahead of the times. Post-war planning is beyond the formulative stage. *The war must be won first!* To this end National is now devoting every facility to making the heavy duty equipment that is so vitally needed. But, with the coming of peace, National will be prepared to meet changed conditions with even better rolls, castings, and machine tool equipment that will materially help to shape the future.

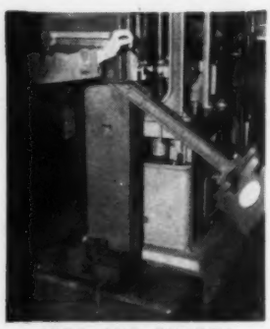
MOBILE X-RAY MACHINE FOR CHECKING PERFECTION IN CASTINGS

METALLURGICAL ANALYSIS IN CHEMICAL LABORATORY



FOUNDRY SAND TESTING EQUIPMENT HELPS PRODUCE BETTER CASTINGS

TENSILE TESTING IN RIEHLE BEAM TYPE MACHINE

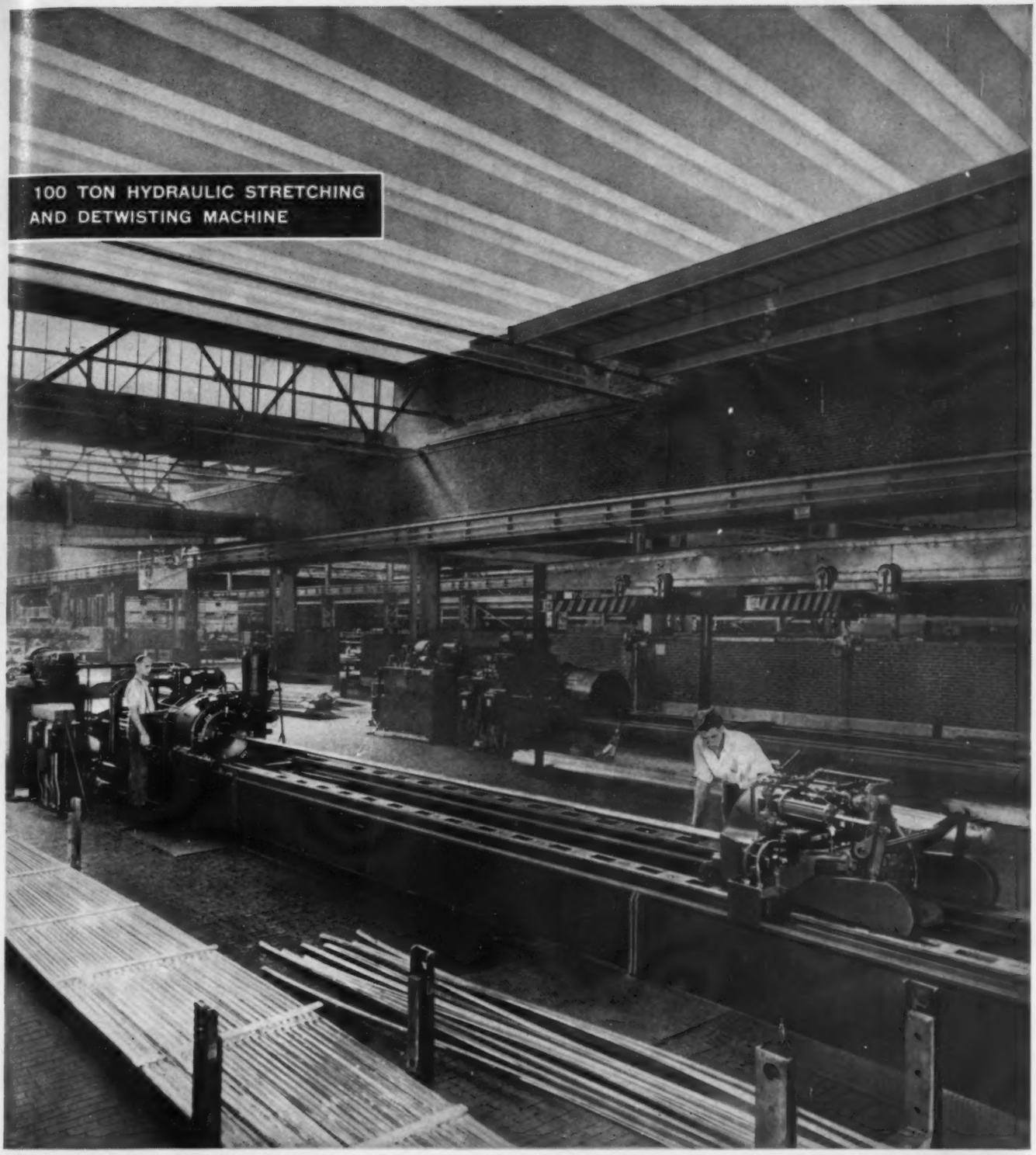


IZOD AND CHARPY IMPACT TESTER

# NATIONAL ROLL & FOUNDRY CO.

## AVONMORE, PENNSYLVANIA

*Manufacturers of:* ALL GRADES OF CAST ROLLS • IRON & ALLOY IRON STEEL & ALLOY STEEL • HEAVY IRON & STEEL CASTINGS • ROLLING MILL EQUIPMENT



100 TON HYDRAULIC STRETCHING
AND DETWISTING MACHINE

# HYDROPRESS · INC.

ENGINEERS CONTRACTORS

**HYDRAULIC PRESSES · ROLLING MILLS**
**STRETCHERS · PUMPS · ACCUMULATORS**

570 LEXINGTON AVENUE · NEW YORK · N Y

# "balanced proportions"

## THE BASIC PRINCIPLES OF THE NEW TIMKEN ROLL NECK BEARING

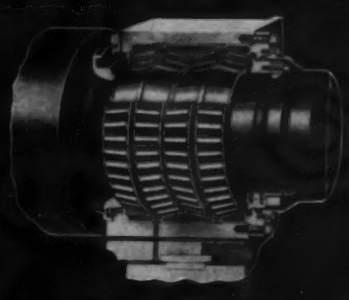
This new Timken Roll Neck Bearing embodies design principles that have been tried and proved by millions of Timken Bearing applications in many different types of mechanical equipment and now are demonstrating their value in roll neck bearings.

We call this new principle "BALANCED PROPORTIONS". Its development involved a careful study of cone and cup angles; roll diameter to roll length proportions; and other factors.

In BALANCED PROPORTION Bearings the ratio of roll diameter to roll length has been entirely changed and a balance made between bearing bore, width and rating for a given bearing outside diameter. Greater mill separating force capacity is obtained without any sacrifice of neck strength. "BALANCED PROPORTIONS" give a considerable increase in bearing bore for a given bearing outside diameter. Thus larger diameter roll necks can be used and neck stresses are greatly reduced under average load conditions at normal mill speeds.

"BALANCED PROPORTIONS" for mill bearings result in exactly the same neck stress in any size bearing of the new series carrying its given rated load.

We will be glad to work with your mill manufacturer in applying this new bearing with its many important advantages to your new mills. The Timken Roller Bearing Company, Canton 6, Ohio.



TIMKEN
ROLL NECK BEARINGS

COPYRIGHT 1945 BY THE TIMKEN ROLLER BEARING CO.

# Hurrah! The Job's Half-Done!

Yes, but *only half* . . . and don't think that the millions of workers in America's war plants and factories don't know it, either.

Sure they're cheering . . . they have a right to!

For who but they, by the labor and skill of their own hands, produced the overwhelming volume of munitions and material needed by our armies to crush the Hun?

In this great achievement, employees of United Engineering and Foundry Company can take just pride; for their record, in the production of ordnance, munitions and processing equipment so vitally needed in the manufacture of war supplies, is one that will be long remembered. Yet they know, as does every worker in America, that Victory lies still ahead . . . that there can be no slackening, no let-down, no rest until peace is wholly won.

. . . only *half* done? True; but remember this: The men and women who have carried the job thus far are *Americans.*

And they'll *finish* it; that's *"for certain."*

***The world's largest designers and makers of Rolls and Rolling Mill Equipment***

**UNITED ENGINEERING AND FOUNDRY COMPANY**

**PITTSBURGH, PENNSYLVANIA**

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

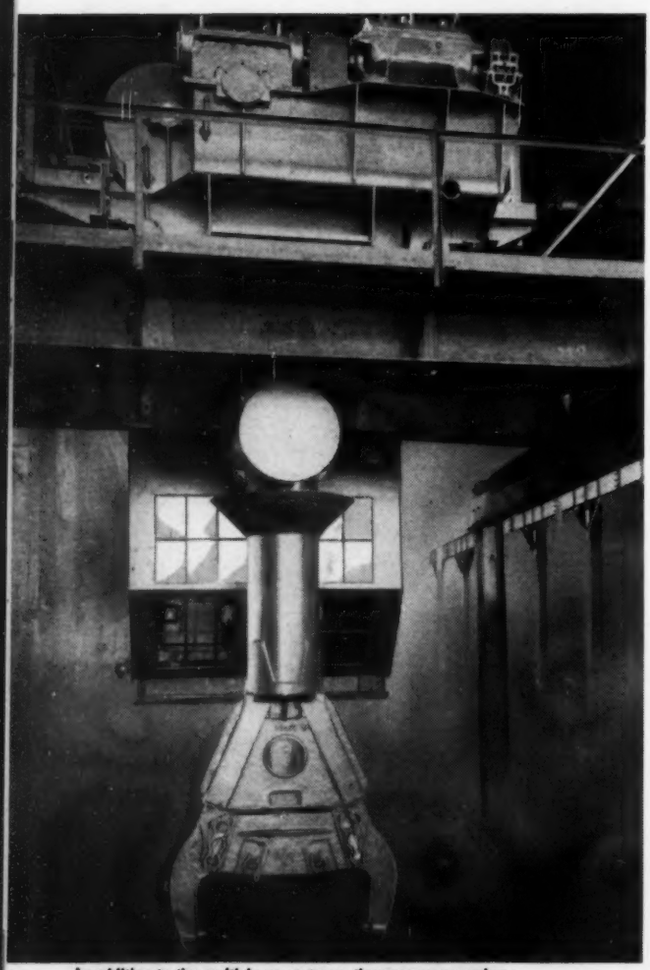
Adamson United Company, Akron, Ohio

*Buy More War Bonds and Stamps*

HERE'S SOMETHING *NEW* IN SOAKING PIT CRANES . . .

# multiple range tongs

ARMY E NAVY



In addition to the multiple range tongs, there are many unique features on this new soaking pit crane, designed by Alliance.

The multiple range tongs, designed and patented by Alliance, represent an advancement in soaking pit crane design.

Alliance developed these new tongs to overcome the troublesome problem of charging and drawing many different size slab ingots with the same crane.

The tongs on this crane are fundamentally different from tongs on conventional soaking pit cranes. By means of an ingenious locking pin, the tongs can be adjusted, *in less than a minute,* to any one of four positions, providing a wide size spread:

> Position (1) takes care of ingots up to 10" x 22"; position (2) — 18" x 40"; position (3) — 36" x 52"; and position (4) — 48" x 60".

Since size adjustments can be made quickly and easily, an operator can handle many more ingots in a given time. By gripping the slabs on the edges, bit marks are eliminated from the rolling surface.

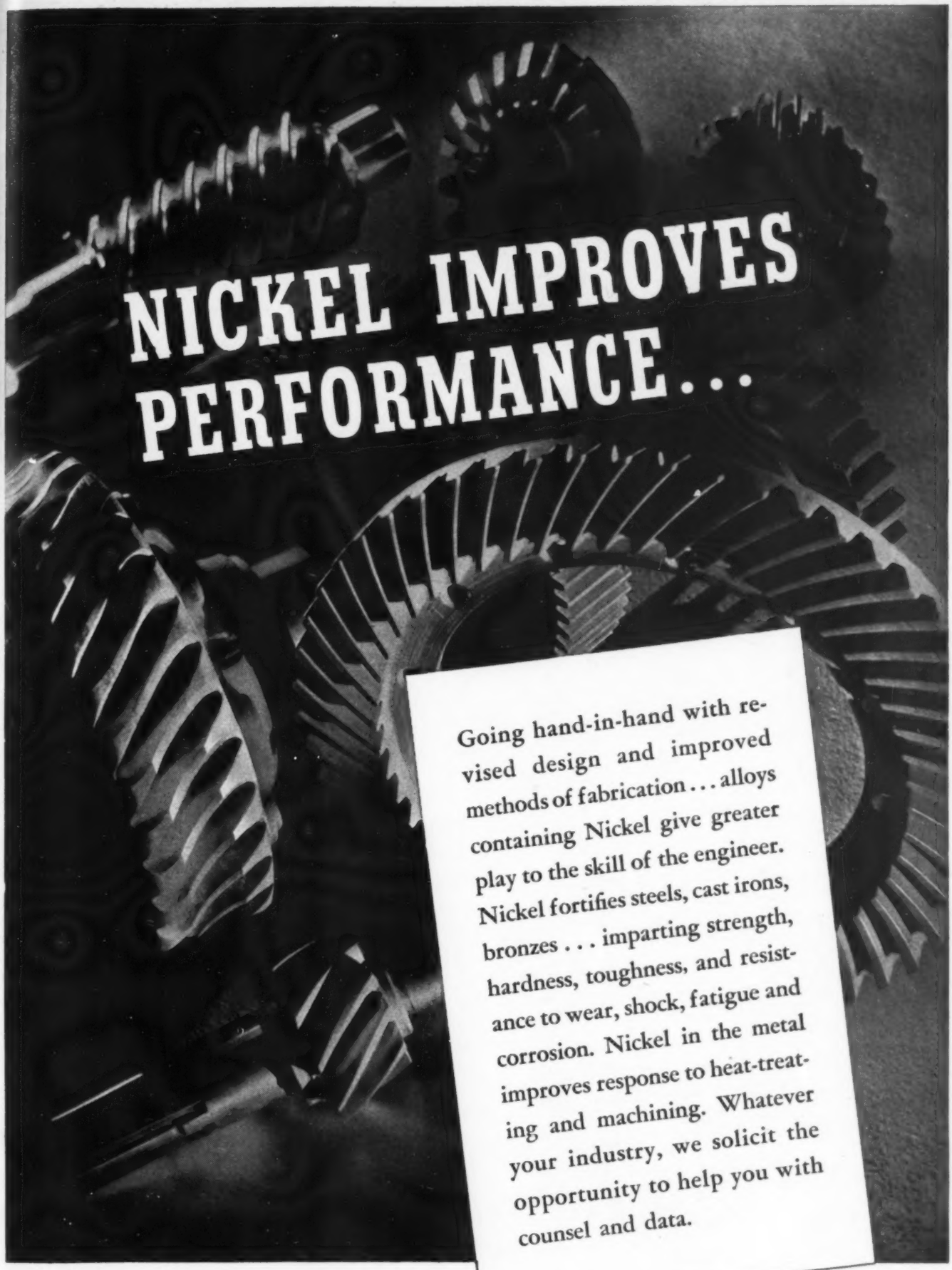
The tongs have the same operating characteristics as a standard soaking pit crane. Consequently, Alliance can install the multiple range tongs *on any existing soaking pit crane, regardless of make.*

As world's largest builders of the world's largest cranes, Alliance has come up with many firsts in crane designing, such as the 4 girder interlocking drum ladle crane, the intensified grip soaking pit crane, and the combination push-pull stripper. The multiple range tongs represent another Alliance first.

We will be glad to discuss this new crane development with you.

THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

PITTSBURGH OFFICE : 1622 OLIVER BUILDING




Going hand-in-hand with revised design and improved methods of fabrication... alloys containing Nickel give greater play to the skill of the engineer. Nickel fortifies steels, cast irons, bronzes... imparting strength, hardness, toughness, and resistance to wear, shock, fatigue and corrosion. Nickel in the metal improves response to heat-treating and machining. Whatever your industry, we solicit the opportunity to help you with counsel and data.

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET NEW YORK 5, N.Y.

*A Fifth Star has been added...*

DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON

5 April 1945

Mr. Lorenz Iversen, President
Mesta Machine Company
P. O. Box 1466
Pittsburgh, Pennsylvania

Dear Mr. Iversen:

It is with heartiest congratulations that the Army and Navy inform the men and women of the Mesta Machine Company that a fifth renewal of the Army-Navy "E" Award was granted your plant at the last meeting of the Navy Board for Production Awards. A new flag with five stars should reach your plant within a few days.

This award, signified by the five stars to be displayed on your "E" flag, is an indication that all of you have maintained the excellent record of production which merited your previous awards. Each and every one of you may well be proud of this high honor and inspiring record.

The courageous men on the fighting fronts must have the necessary weapons with which to wage total war. These men appreciate the vital support of the men and women of the Mesta Machine Company who have worked with such untiring effort on the production front to supply these needed war materials.

Sincerely yours,

C. C. Bloch

C. C. BLOCH
Admiral, USN (Ret.)
Chairman, Navy Board for Production Awards

## "for the Excellent record of War Material Production"

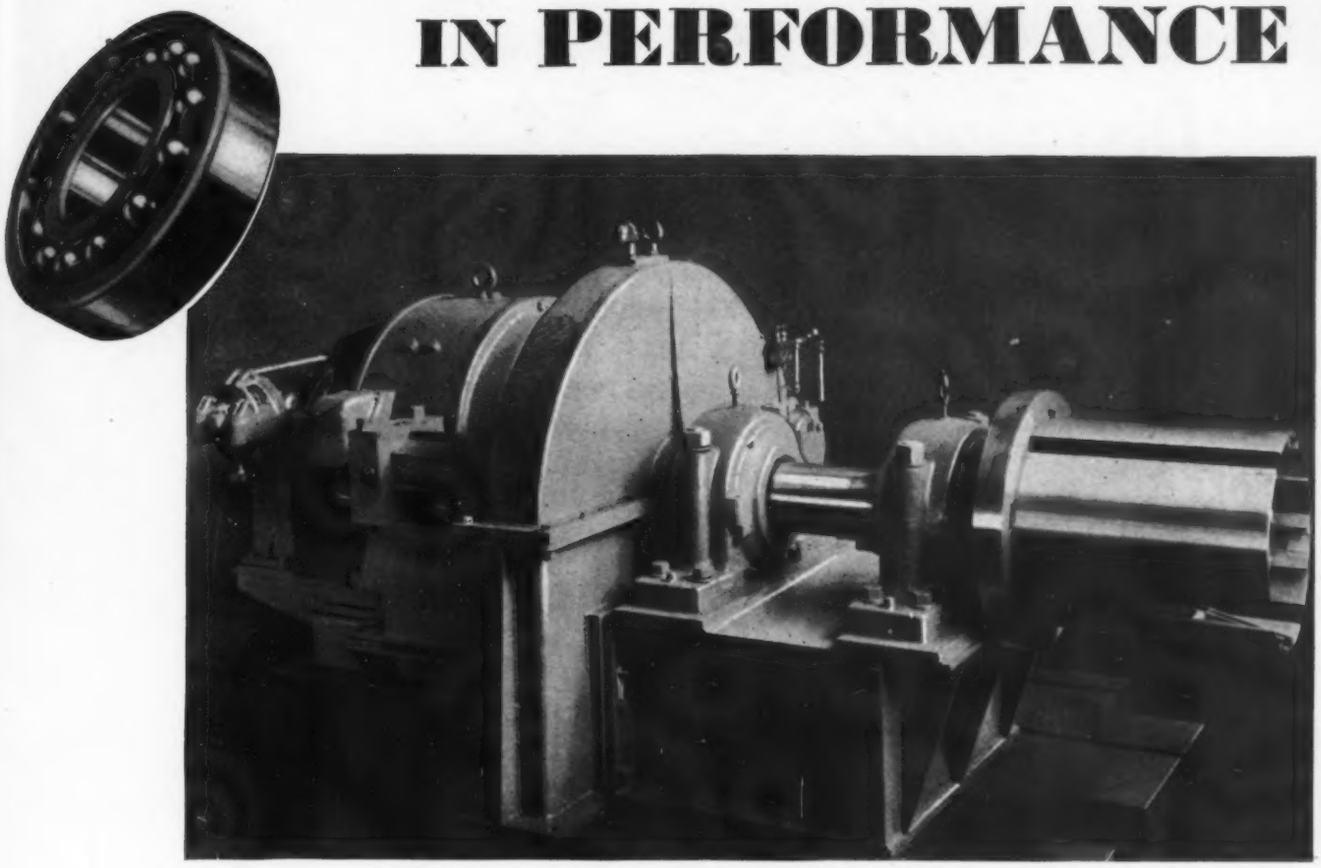
On September 11, 1941 Mesta Machine Company received one of the first "E" awards presented by the Navy Bureau of Ordnance. They later received the all-Navy "E" Burgee and subsequently the Army-Navy "E", to which has now been added the fifth star. Each of the five stars signifies recognition of a continuation of outstanding war production which merited the initial honor.

**Rolls · Steel Mill Equipment**
**Heavy Duty Machine Tools**
**Forgings**

*"ALL OUT FOR THE MIGHTY 7TH WAR LOAN"*

# MESTA MACHINE CO., PITTSBURGH, PA.

# UNWINDERS PAY OFF IN PERFORMANCE

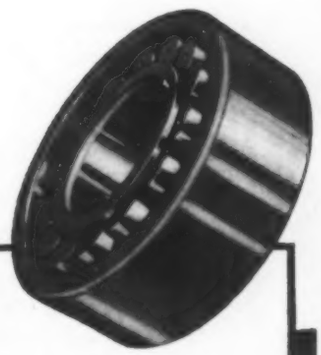


● *Built by* WATERBURY-FARREL FOUNDRY & MACHINE CO.

From the time it starts unwinding a ribbon of steel until the reel is empty, this machine pays off in smooth, reliable performance. It's an 18″ x 22″ Unwinder with two SKF Spherical Roller Bearings in SKF Pillow Blocks on the pay-off shaft and SKF Ball Bearings on the high-speed shaft. With a bearing combination like that working faithfully 24 hours a day, week in and year out, there's built-in alignment to assure high load capacity at all times. There's equalized load distribution extending throughout a long life. There's freedom from adjustments and constant lubrication. Plus-performance is the pay-off from any SKF-equipped machine . . . any time.

5809

SKF INDUSTRIES, INC., PHILADELPHIA 34, PA.

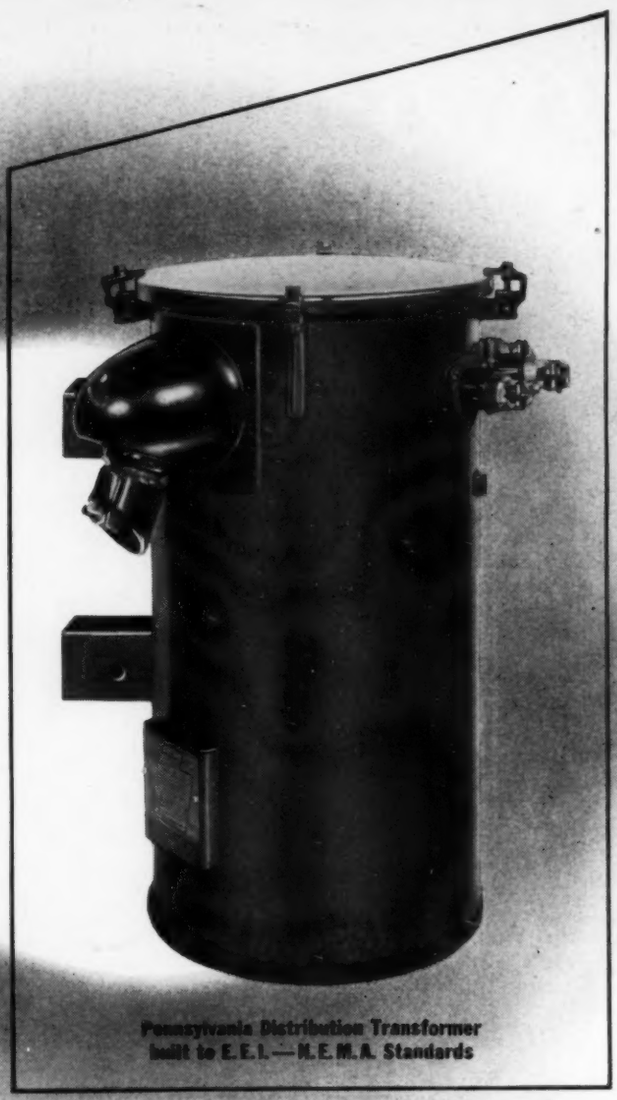


Pioneering in practically all industries, SKF produces ball and roller bearings of all types and sizes, from ⅛″ to 59″ O.D.

SKF
PUTS THE RIGHT BEARING IN THE RIGHT PLACE

SKF
BALL AND ROLLER BEARINGS

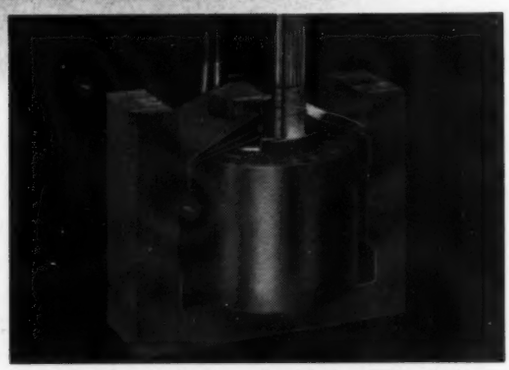
# Every Pennsylvania Distribution Transformer gives you these electrical and mechanical advantages



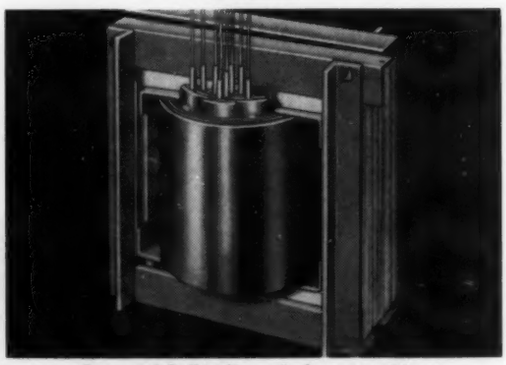
Pennsylvania Distribution Transformer built to E.E.I.—N.E.M.A. Standards

- Core is built up of individual laminations varnished on both sides. It operates at a low density which results in low exciting current at normal voltage as well as at over voltages.
- Circular Coils are wound tightly with uniform tension, eliminating possibility of stretching the wire and injuring the insulation.
- Coils are mounted concentrically on Core and held firmly in place, thus eliminating possibility of movement during transportation or in service.
- High Voltage and Low Voltage Coils are readily removable from Core as a unit, permitting minor repairs or replacement of Coils with minimum time and expense.
- Generous size of Core and Coils results in high, short-time overload capacity.

A thorough knowledge of transformer design, supplemented by a careful analysis of operating and maintenance problems, have resulted in many desirable operating features being incorporated in Pennsylvania Distribution Transformers. Some of these are listed above.



Coil mounted firmly on Core before yoke steel is built in.



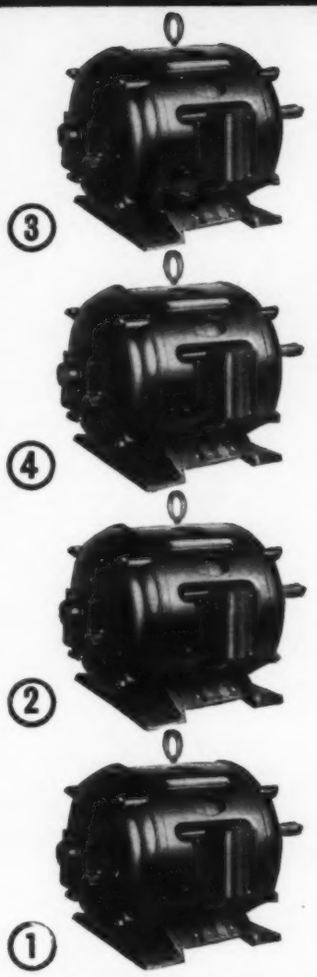
Core and Coil unit ready for assembly.

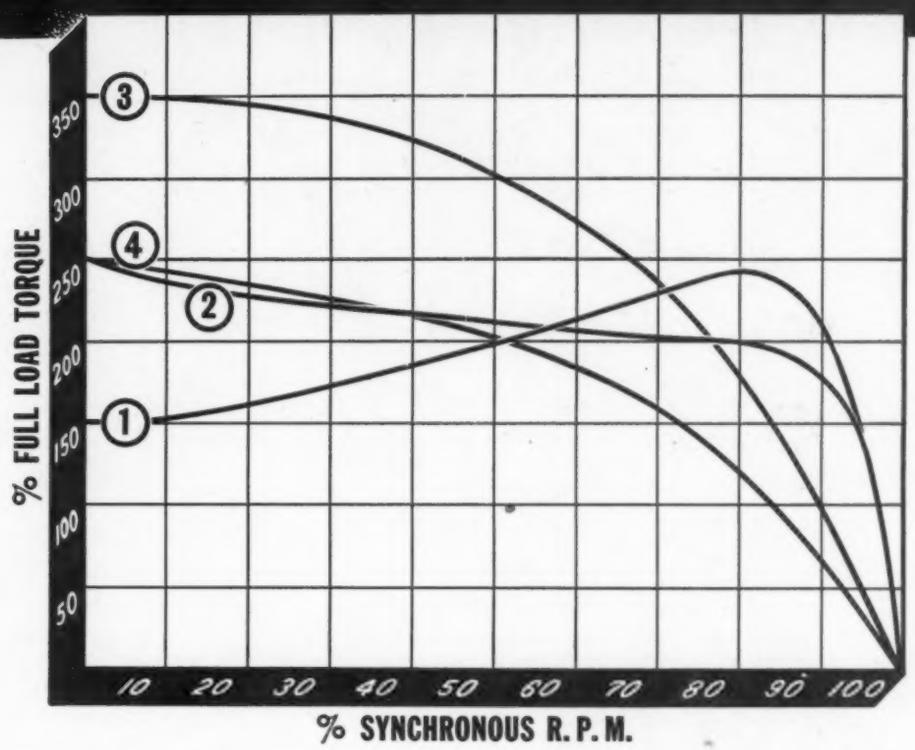
Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, N. S., PITTSBURGH 12, PA.

# Which Squirrel-Cage Motor for the Job?

## THESE FOUR MOTORS LOOK ALIKE—BUT THEY ARE BUILT FOR ENTIRELY DIFFERENT APPLICATIONS




The selection of the right type of motor for any given application involves a thorough knowledge of the electrical characteristics of motors. These four motors look alike externally and internally, but they are entirely different in electrical performance. The same mechanical parts are used in their construction and their windings are insulated alike, but each type is suitable for a certain kind of job. All of their windings are braced for full-voltage starting and none of them need be operated with voltage-reducing devices. The essential differences between these motors are apparent only from a study of their speed-torque curves.

**CURVE 1** is a typical speed-torque curve of a Wagner type RP-1 normal-torque motor. This motor has a higher breakdown torque at a higher speed than any of the others and therefore is capable of carrying greater momentary overloads. It has a starting torque fifty percent greater than the full-load torque, and a full-load speed of about three percent less than synchronous speed. This type of motor is suitable for such a wide variety of applications that it is often called a general-purpose motor. It should not be used on jobs which require high-torque, punch-press, or elevator motors.

**CURVE 2** is a typical speed-torque curve of a Wagner high-torque type RP-5 motor. This motor has a flatter torque curve and considerably less breakdown torque than the type RP-1. It has a starting torque from two to two-and-a-half times the full-load torque and about the same full-load speed as the type RP-1. The RP-5 motor is suitable for driving crushers, compressors, and other machines which are hard to start.

**CURVE 3** is a typical speed-torque curve of a Wagner type RP-6 punch-press motor. This motor develops its greatest torque at standstill and has a starting torque from three to three-and-a-half times the full-load torque. It has a much lower full-load speed than the type RP-1 and RP-5 motors and therefore slows down considerably when the punch-press forms or pierces its work, allowing the punch-press fly-wheel to deliver its stored energy and reducing the work done by the motor. The RP-6 motor should be used on any machine which has a heavy flywheel or flywheel effect.

**CURVE 4** is a typical speed-torque curve of a Wagner type RP-7 or elevator motor. It has lower starting torque and lower full-load speed than a punch-press motor and therefore can smoothly accelerate and operate an elevator, hoist, or dumbwaiter which must be started, stopped, and reversed frequently.

***For Complete Information*** write for Motor Bulletin MU-185 which fully describes Wagner squirrel-cage polyphase motors, as well as all other types of Wagner single-phase, polyphase, and direct-current motors.

M45-10

**MOTORS** are but one of several **WAGNER PRODUCTS** serving industry.

Other WAGNER PRODUCTS:
AIR BRAKES
BRAKE LINING
HYDRAULIC BRAKES
INDUSTRIAL BRAKES
INDUSTRIAL BRAKE CONTROLS
NoRel
TACHOGRAPH (Recording Speedometer)
TRANSFORMERS

ARMY E NAVY

# Wagner Electric Corporation

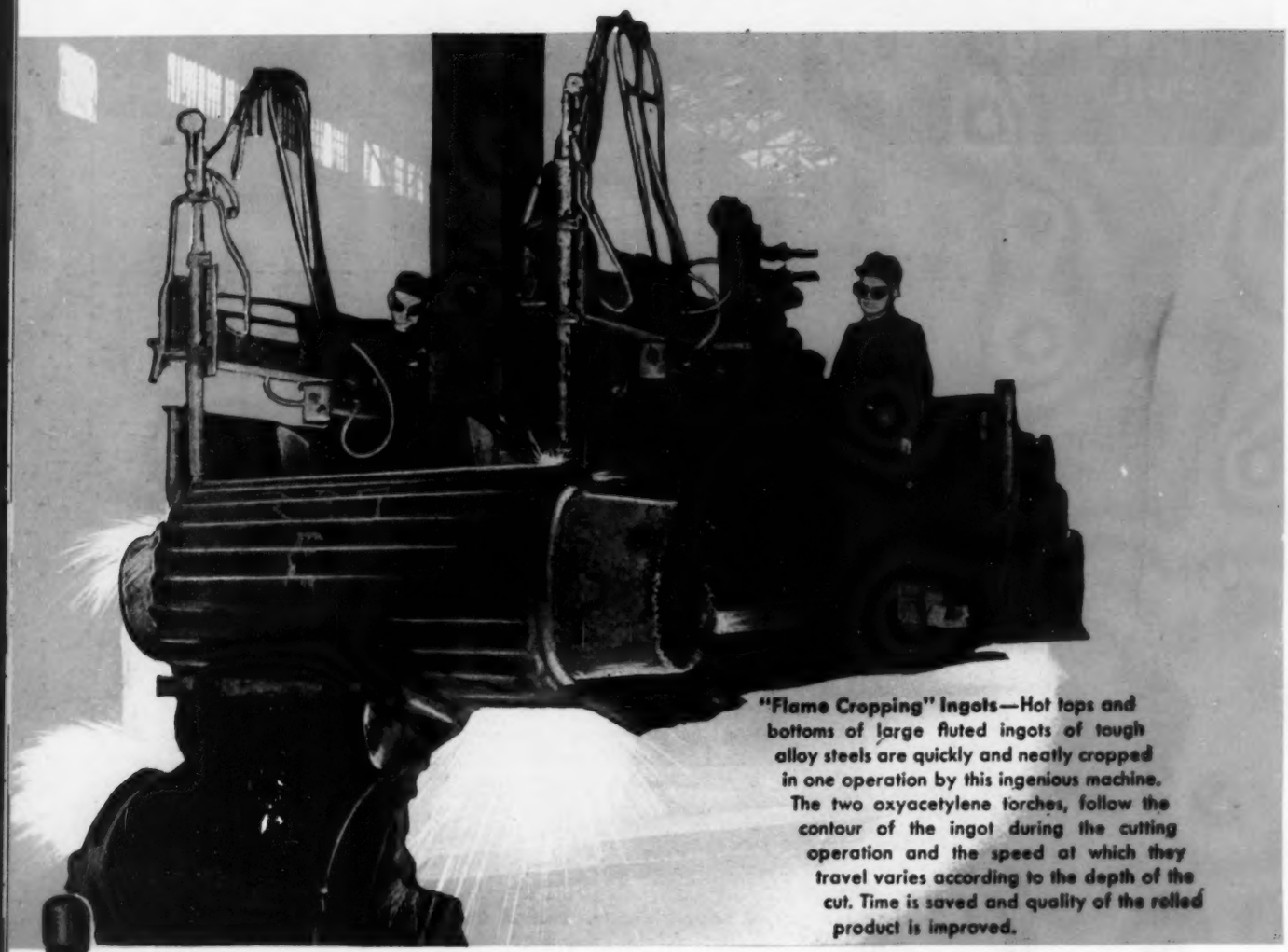
ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

Wagner squirrel-cage motors discussed in this advertisement are but four motors built by Wagner. There are other types of polyphase motors, and several types of single-phase and direct-current motors making up the Wagner line. No matter what your requirements may be, there's a Wagner motor ideally suited for the job.

# Airco Processes Help "Steel"



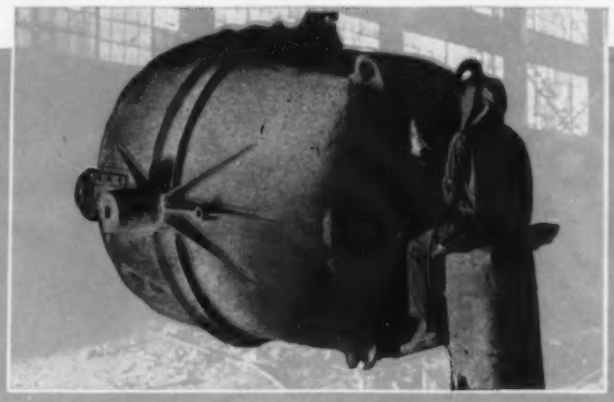
**"Flame Cropping" Ingots**—Hot tops and bottoms of large fluted ingots of tough alloy steels are quickly and neatly cropped in one operation by this ingenious machine. The two oxyacetylene torches, follow the contour of the ingot during the cutting operation and the speed at which they travel varies according to the depth of the cut. Time is saved and quality of the rolled product is improved.

IN satisfying the 90-million-ingot-ton appetite of modern mechanized war, America's steel industry has found able allies in oxyacetylene flame and electric arc methods developed by Airco. From ore ranges to shipping docks, these versatile processes are helping the mills to keep overworked equipment running smoothly, boost tonnage figures and meet the quality standards demanded by the armed forces of the United Nations.

Airco's Applied Engineering Department is always at the call of iron and steel engineers and production men to assist in applying these and other Airco processes to the solution of their problems. For additional information, get in touch with your nearby Airco office or, if you prefer, direct your inquiry to Dept.....at the New York address.

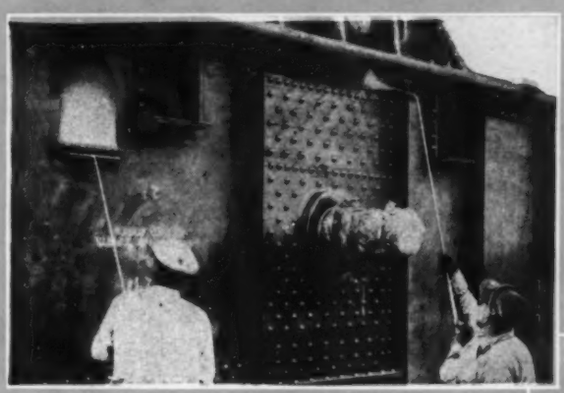
AIRCO

# Meet War's Demands . . .



**Maintenance Welding**—From ladles to laboratory equipment, oxyacetylene and electric arc welding help to keep the vital tools of steel production on the job. Quick repairs by welding save time and eliminate costly shutdowns.

**Welding Pipe**—Welding with either the oxyacetylene torch or the electric arc, has largely replaced threaded couplings and fittings in steam, water, gas, fuel and air lines in and around mills. Construction time is reduced and the lines withstand severest kinds of service without danger of leakage.



**Flame Cleaning and Dehydrating of Structurals**—Using special tips, the oxyacetylene flame drives out moisture and removes dirt, grease and loose scale from new steel surfaces, providing a better base for the protective paint coat. Flame cleaning old structures with the same equipment before repainting removes old paint, loose scale and rust and drives out entrapped moisture, assuring longer life for the repaint job.

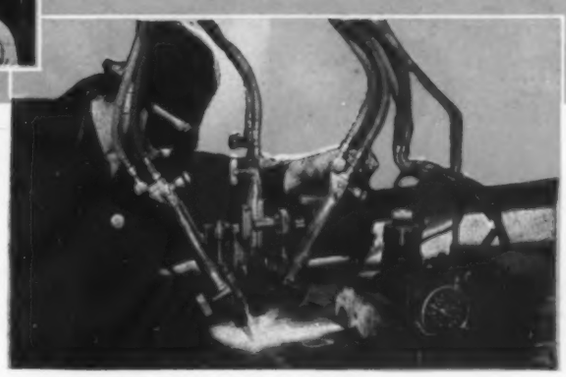


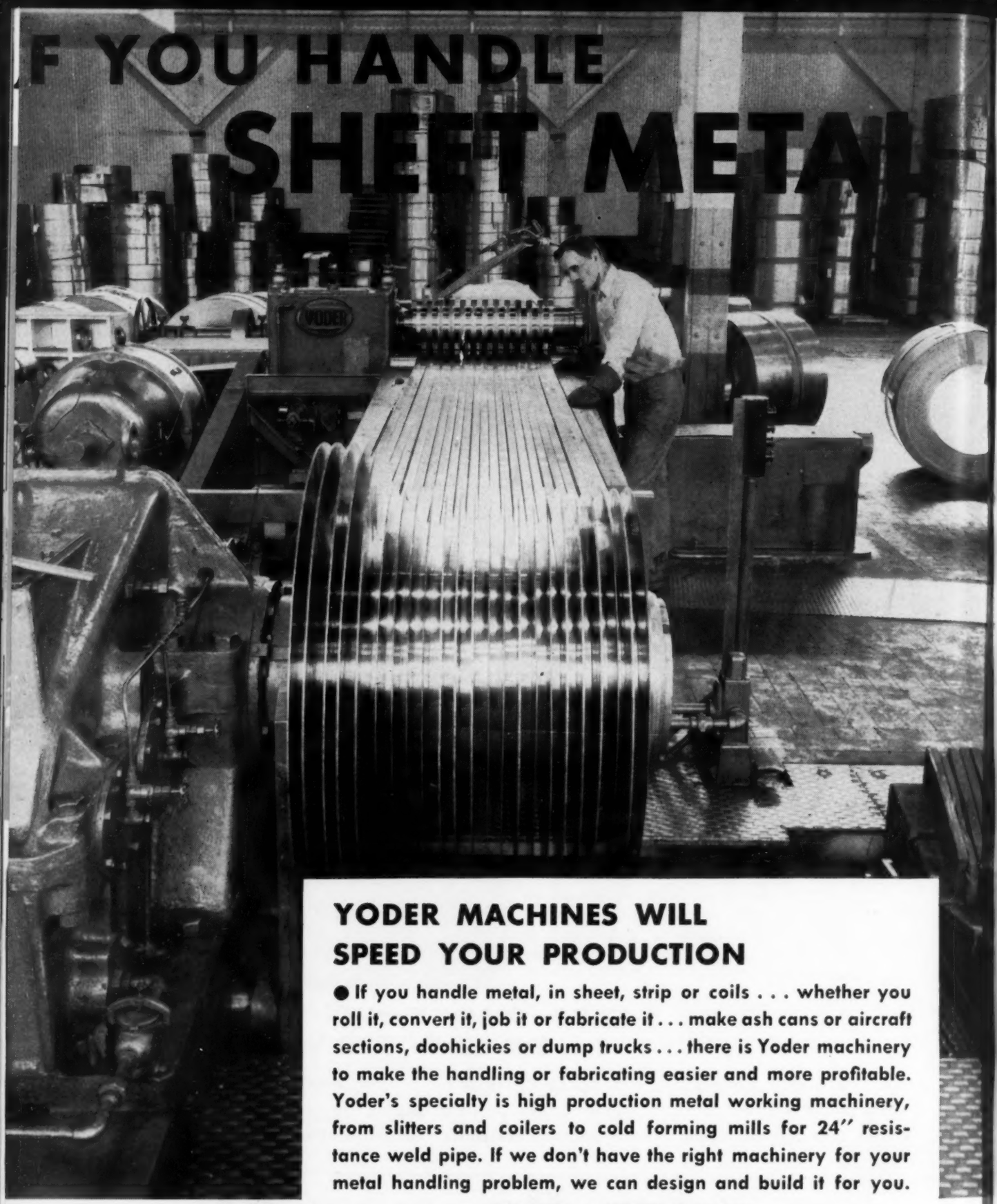
**Plate Edge Preparation for Welding**—Small, light-weight Airco Radiagraphs cut straight lines, circles and arcs in steel plate and prepare the edges for welding with straight butt edge, "V" groove, single or double "U" groove, single or double "J" groove or double bevel groove without land.

## OTHER AIRCO PROCESSES TO AID STEEL PRODUCTION

FLAME SCARFING AND DESEAMING
OXYGEN LANCING
SCRAP CUTTING
MACHINE GAS CUTTING
BRONZE WELDING
HARDFACING
CONTROLLED ATMOSPHERES


**AIR REDUCTION**

General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.
In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS
*Offices in all Principal Cities*




## YODER MACHINES WILL SPEED YOUR PRODUCTION

● If you handle metal, in sheet, strip or coils . . . whether you roll it, convert it, job it or fabricate it . . . make ash cans or aircraft sections, doohickies or dump trucks . . . there is Yoder machinery to make the handling or fabricating easier and more profitable. Yoder's specialty is high production metal working machinery, from slitters and coilers to cold forming mills for 24" resistance weld pipe. If we don't have the right machinery for your metal handling problem, we can design and build it for you.

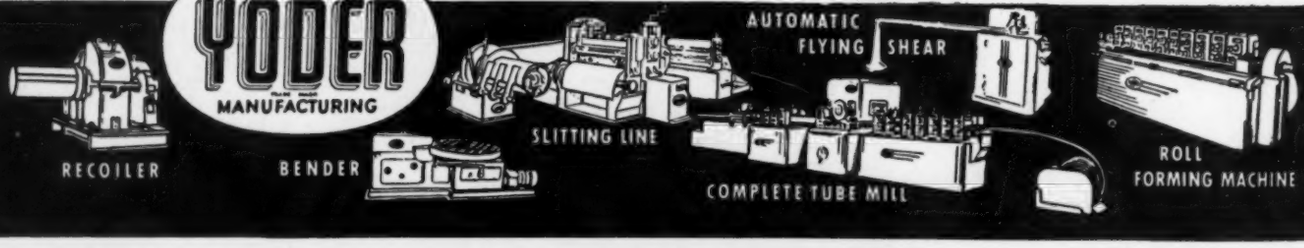
*ASK FOR A YODER BULLETIN*

METAL • WORKING • PRODUCTION • MACHINERY •

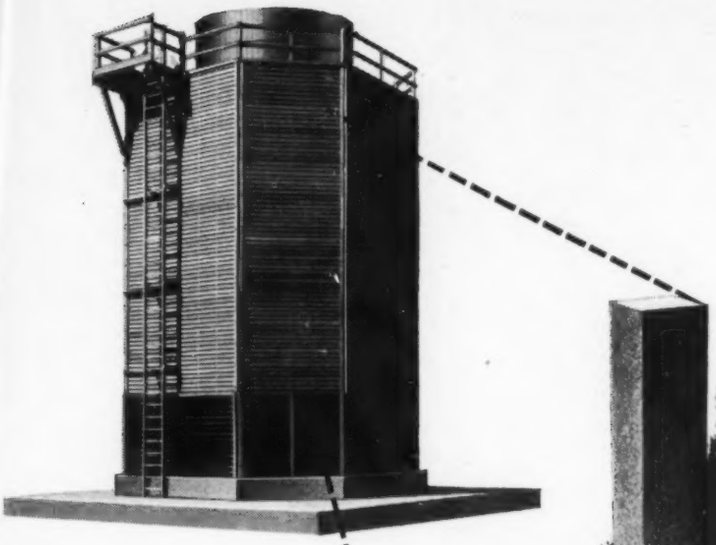
ENGINEERING

YODER

MANUFACTURING




5526 WALWORTH AVE., CLEVELAND 2, OHIO



# HOW MUCH COOLING PER SQUARE FOOT?

EXTENSIVE field tests and years of work on experimental towers prove that LONGER and MORE THOROUGH contact between air and water are essential to today's critical cooling tower requirements. In the CFN Cooling Tower, every square foot of horizontal area ...from top to bottom...contributes to the greater efficiency of the entire unit because air-water contact is longer and more thorough. And this isn't all!

In the CFN Cooling Tower, upspray distribution assures maximum water breakup. The elimination of 90° corners removes dead air pockets which in conventional towers permit hot water to "funnel" direct from the distribution system to the basin without getting full benefit of cooling air. Octagonal design also allows greater air intake capacity with less friction loss. Greater height in proportion to section area means greater distance between intake and discharge and minimizes re-circulation.

ALL designs for FLUOR *Aerator* Cooling Towers and FLUOR *Counter-Flow* Induced Draft Cooling Towers are fully protected by U. S. Patents and Patents Pending.

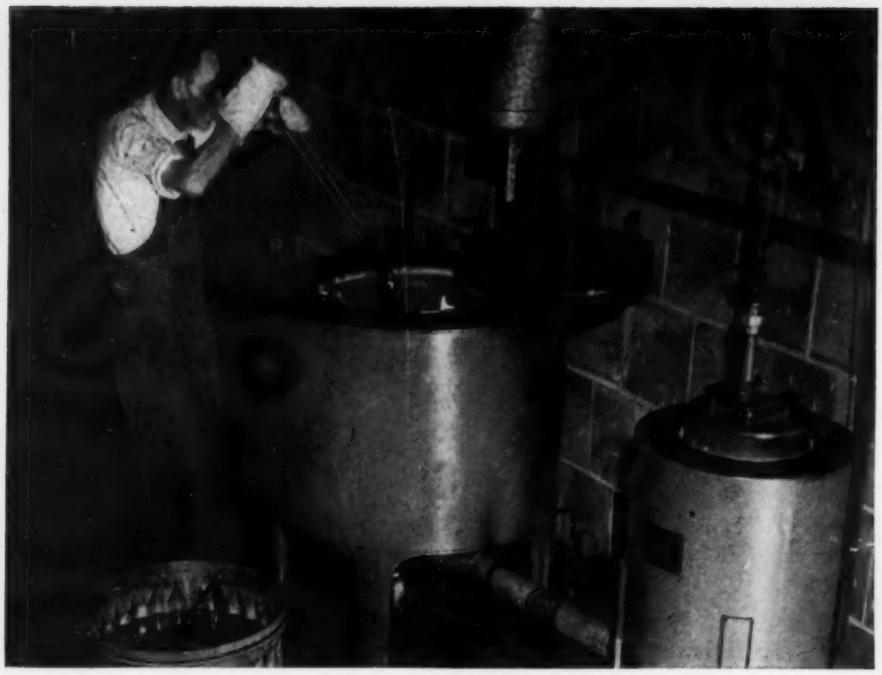
BE SURE WITH FLUOR SINCE 1890

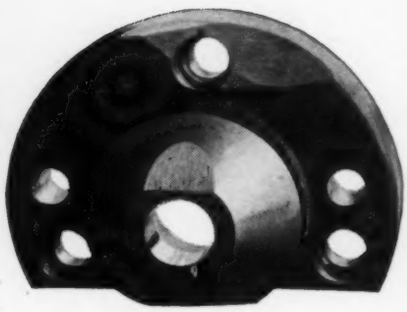
# FLUOR

**ENGINEERS • MANUFACTURERS • CONSTRUCTORS**

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa, Boston





A die of Crucible's "Airdi" No. 150 steel (Chrome-moly-vanadium) goes into the Vapocarb-Hump Hardening Furnace at McGraw Electric Co. Right: Hardened and Homo-tempered die.

*depends on me!*
*A Slogan For Every American*

# NO SCALE - - - NO DECARB - - - IN TOASTMASTER'S

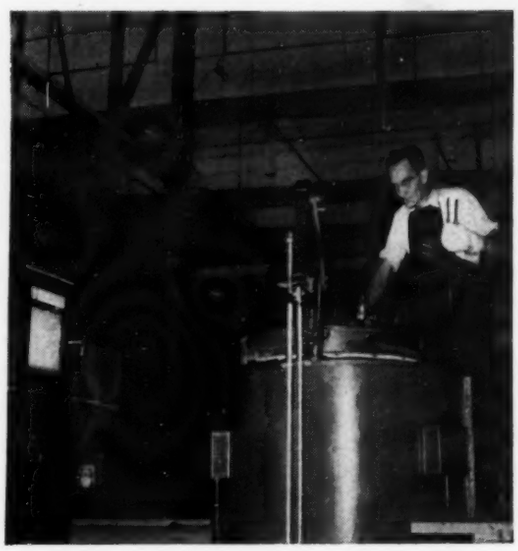
## VAPOCARB-HUMP HEAT-TREAT

This coining and blanking die is typical of the dies and die parts being hardened by the Vapocarb-Hump Method and tempered by the Homo Method at Toastmaster Products Division of McGraw Electric Company, Elgin, Illinois. The die's smooth surface and carefully-controlled structure are typical of *all* parts treated in L&N all-electric furnaces.

There's no guesswork in these methods — all variables are under control. In the Vapocarb-Hump, protective Vapocarb gas completely envelops the work and refuses to allow soft spots due to vapor pockets or adherent scale. A Micromax Recording Controller prevents the normal furnace head (normal temperature difference between work and furnace) from being exceeded; it reduces the heat when work enters the critical — increases it later as desired.

The findings of two thermocouples — one detecting *work* temperature, the other detecting *furnace* temperature — appear on the chart of the Micromax Recording Controller. This complete temperature picture, plus the location of the critical range, enable the heat-treater to heat accurately and to find the quench point which will give "perfect" surface, correct structure, and long tool life.

An L&N engineer will gladly see you regarding a specific heat-treating problem, or will send a Catalog, as you prefer.



Companion to the Vapocarb-Hump, this L&N Homo-Tempering Furnace is a quick, clean, and accurate means of stress-relieving hardened parts. The furnace comes to temperature rapidly — has a large capacity. The heat-treater simply sets the Micromax Controller for the temperature which will give best results.

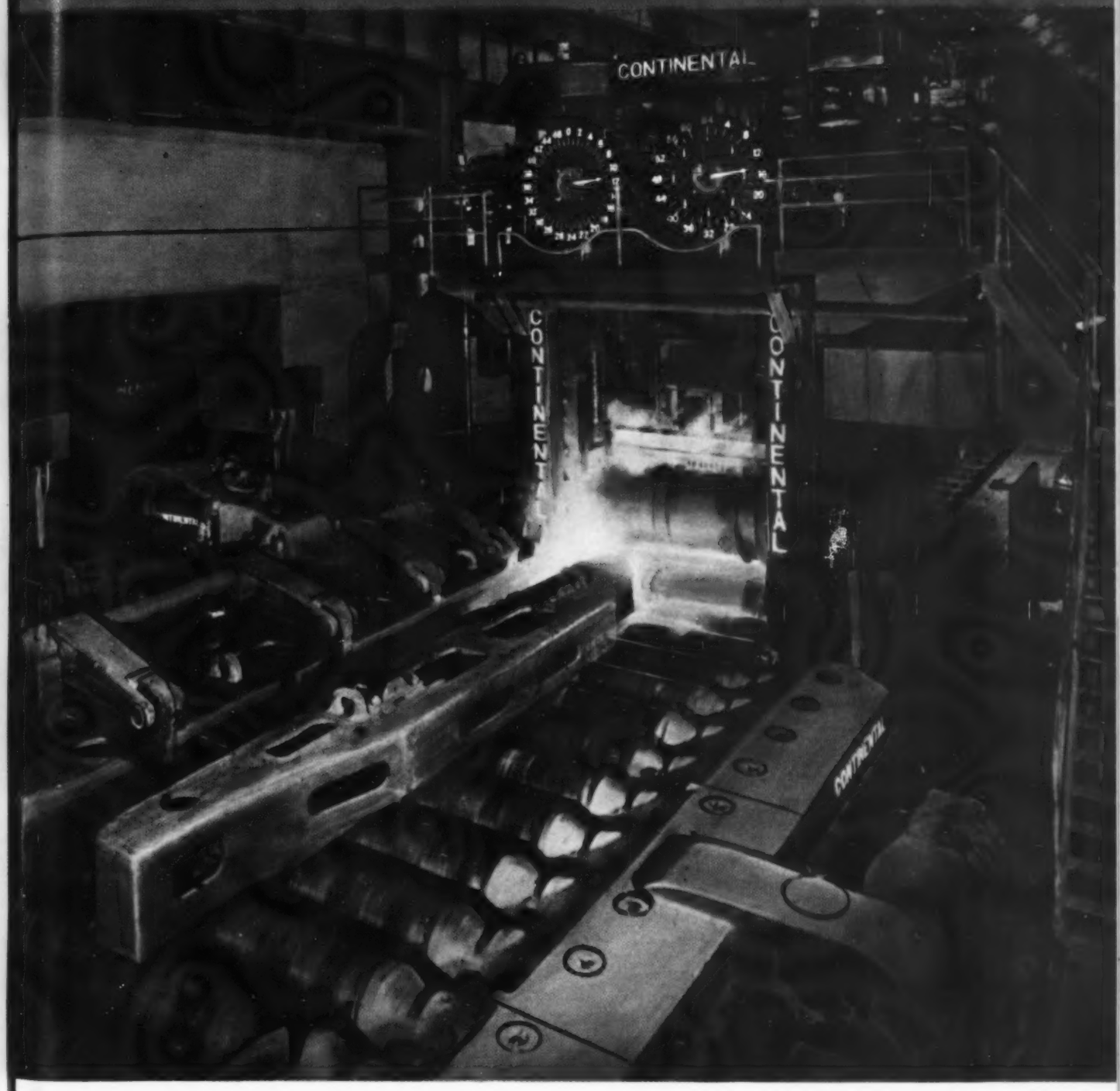
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad T-620(19)

# 44 INCH REVERSING BLOOMING MILL
# DESIGNED AND BUILT BY CONTINENTAL

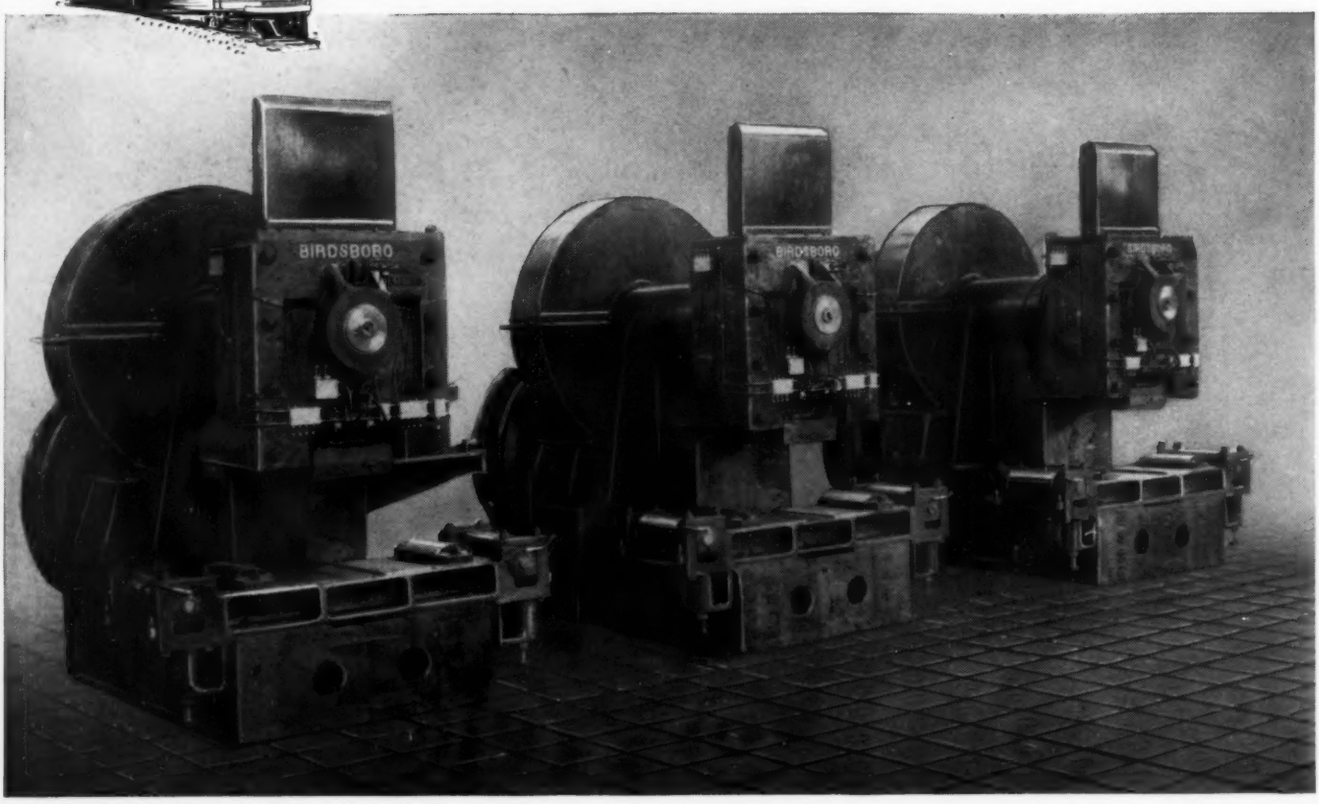



# CONTINENTAL
## FOUNDRY & MACHINE COMPANY

CHICAGO • PITTSBURGH

| CHICAGO WORKS | PITTSBURGH WORKS | WHEELING WORKS | WARWOOD WORKS |
|---|---|---|---|
| East Chicago, Ind. | Coraopolis, Pa. | Wheeling, W. Va. | Wheeling, W. Va. |

# THEY HELP *Smooth Your Rides!*




THE job of these 3 Birdsboro 125-ton presses is straightening 150 lb. rails up to 90′ long. They help make your train rides smoother and safer. More important, they help make rail straightening jobs easier, less costly.

These particular machines have bottom anvils adjustable from 30″ to 50″. A pair of spring-cushioned rollers support the rail being straightened. Flywheels and gears are enclosed for maximum safety in operation.

If you want "smoother riding" on your straightening jobs, consult Birdsboro. Our engineers will be glad to apply their diversified experience to your specific problems.

**BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY**
**BIRDSBORO, PENNA.**

BUY WAR BONDS

**BIRDSBORO**
**STEEL MILL EQUIPMENT**

# ROLLING AROUND THE CLOCK ... AROUND THE CALENDAR

**—without replacing a single bearing!**

Night and day for a solid year—475,000 tons without a breakdown—that's the sort of unprecedented production records being rolled up by N-B-M #200 Bronze Plate and Blooming Mill Bearings.

In plant after plant, where the life of babbitted steel shells was measured in *weeks*, these new N-B-M #200 Bronze Bearings are giving: 10 times longer service • Far more tonnage • More uniform gauge • Freedom from cut roll necks • Substantial savings in power and maintenance costs.

May we send you details of individual installations?

**N•B•M BRONZE AND COPPER CASTINGS**

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers
Housing Nuts • Machinery Castings • Acid Resisting Castings
Phosphorized Copper • Babbitt Metals

**NATIONAL BEARING**
DIVISION
PITTSBURGH • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

# The Mackintosh-Abramsen straightener

## *removes end bends*

THE MACKINTOSH-ABRAMSEN STRAIGHTENER speeds up production, cuts operating costs and delivers an absolutely straight product—end to end.

There are no guides to ring or score the stock. The action of the rolls can be controlled to produce the exact quality of surface finish that is required. Elimination of supporting guides, the use of symmetrical passes, and a balanced arrangement of the drives, result in a very considerable power saving—the power consumed per foot of product sized or straightened is usually about fifty per cent of that required by other machine types.

Because Mackintosh-Abramsen straighteners are not closed in, all parts can be easily reached for rapid adjustment and roll changes. This feature results in less "down-time,"—more production.

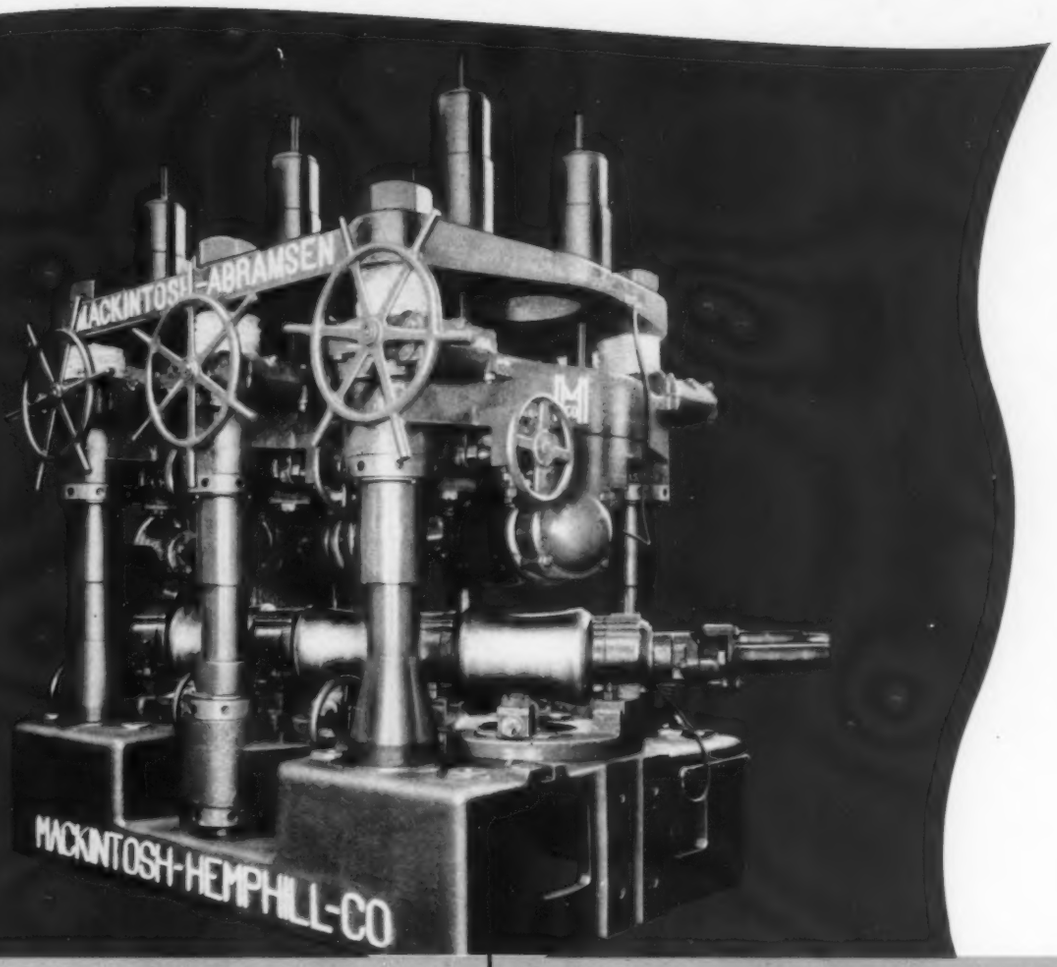
By setting the middle pair of rolls out of line in relation to the other two pairs, an ideal condition for end to end straightening is accomplished thus guaranteeing absolute straightness of stock. The double roll middle pass prevents weaving or sidewise movement of the stock and causes straightening of long bends and end camber to take place in three passes instead of one. The bending action on the stock takes place from the end of the rolls in the first pass to the end of the rolls in the middle pass, and again from the middle pass to the third pass. Thus the bending or straightening action on the stock is from section to section of the stock, and is not dependent on the contour of the rolls.

The symmetrical contour of the rolls forming the three passes and the balanced arrangement of the driven rolls result in a uniform wear on the surface of the roll. The rolls are continuously "wearing in" instead of "wearing out." The machine, therefore, requires fewer roll dressings and, hence, gives greater roll life.

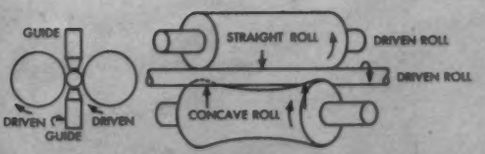
The straightener is available for cold finishing of hot rolled or cold drawn bars up to 9″ diameter, and tubing or pipe in all sizes from ¼″ O.D. to 28″ O.D. On some products, production speed in excess of 500 feet per minute is attained.

MACKINTOSH-HEMPHILL COMPANY, *Pittsburgh and Midland, Penna.*

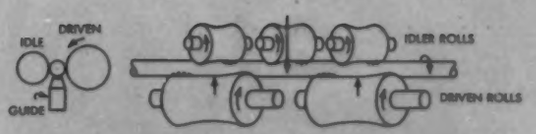
***Makers of the Rolls with the Red Wabblers***




## PRESENT-DAY PRACTICE




**Method No. 1: Straightening is done in one set of cross rolls. Guides are used to hold material on the pass line. The straightening takes place from point to point on the rolls and against the guides. Efficiency drops with wear on the rolls.**




**Method No. 2: Straightening is done by a pressure roll between two cross roll passes—Material is held on the pass line by a bottom guide—The straightening takes place from point to point on the rolls and against the guide. Efficiency drops with wear on the rolls.**

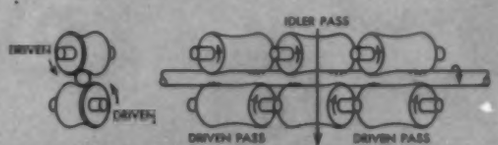
## Investigate the possibilities of the Mackintosh-Abramsen Straightener

**it will:**

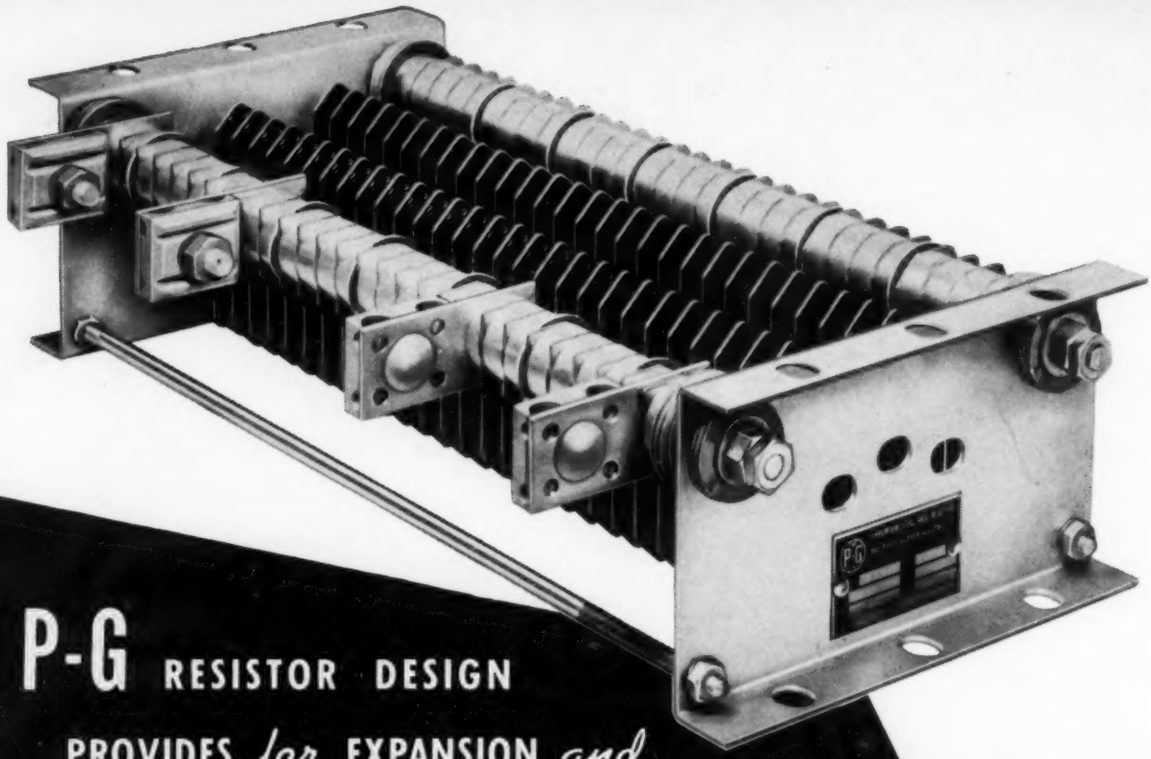
1. Give you a straighter product hot or cold
2. Give you a smoother, cleaner product
3. Increase production rates
4. Lower production costs
5. Remove out of roundness

**it won't:**

1. Spiral mark thin wall tubes or soft material
2. Guide score finished material
3. Unduly harden ductile materials
4. Destroy the surface on coated materials




**The Mackintosh-Abramsen Method—Straightening is accomplished by an offset cross roll pass between two fixed cross roll passes (patented)—No guides are required because the rolls are driven on both sides of the material which is supported by the bottom rolls. With this balanced arrangement there is no decreasing efficiency from uneven wearing of the rolls. The straightening takes place from section to section and not from point to point.**



# P-G RESISTOR DESIGN PROVIDES *for* EXPANSION *and* MAXIMUM VENTILATION . . . .

- ★ ALL STEEL CONSTRUCTION
- ★ MICA INSULATION
- ★ RUGGED TERMINALS
- ★ PROVISION FOR EXPANSION
- ★ ADEQUATE VENTILATION
- ★ UNAFFECTED BY VIBRATION
- ★ MOISTURE RESISTANT
- ★ CORROSION PROTECTED

• The exclusive "P-G Floating Bolt" construction permits the resistor element to expand without buckling as the temperature increases under load. Thus, damage from expansion or buckling . . . a frequent source of resistor trouble . . . is eliminated.

The unique shape of the "P-G Steel Grid" assures maximum ventilation because of the even heat distribution over the entire grid surface. Each part of the grid is equally exposed to air and the heat produced is rapidly dissipated.

These and many other practical features of design, plus steel and mica as basic materials, assure long resistor life.

Detailed information in
BULLETIN No. 500
*Copy on request*

P-G

*The Nonbreakable Steel Grid Resistor*

**THE POST-GLOVER ELECTRIC COMPANY**

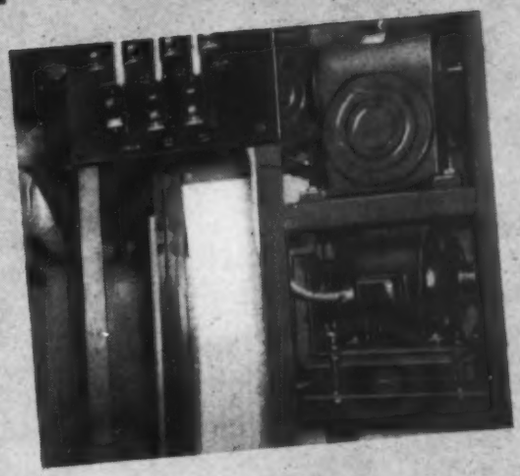
• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

# IN STUFFY SPOTS

Many a motor must be located where walls, adjacent equipment, or materials cut down the free flow of air. Sometimes, as in the case of this wool-dryer drive, surroundings are hot, and stuffy, too.

Tri-Clad motors have proved themselves cool-running even under such conditions. Their powerful, double-end ventilating system moves the air at controlled velocity for effective heat removal. The location and baffling of dual exhaust ports discourage recirculation.



Tri-Clad motor drives conveyor on wool dryer—Bigelow Sanford Carpet Co., Amsterdam, N. Y.

## AIR-FLOW TESTS OF TRI/CLAD MOTORS LEAD TO PROTECTION FROM OVERHEATING

Plenum chamber test of Tri-Clad motor ventilation at G-E motor factory.

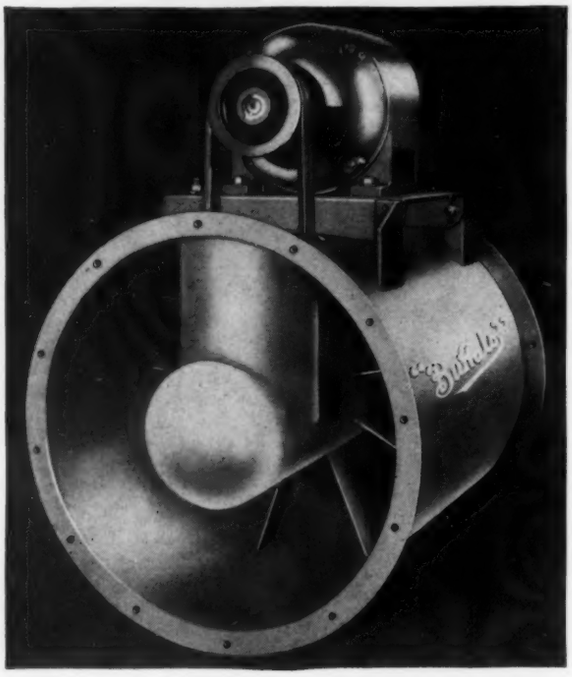
Before new types or sizes of Tri-Clad motors are approved for production, plenum chamber tests are conducted on the ventilating systems of sample models. These measurements serve as a check on previous calculations of the volume and velocity of air through the motor under different conditions. Other tests under load within enclosures and at abnormal ambient temperatures are also made. If your motors must be confined in stuffy spots, G.E. can help you make the right choice to beat the heat. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

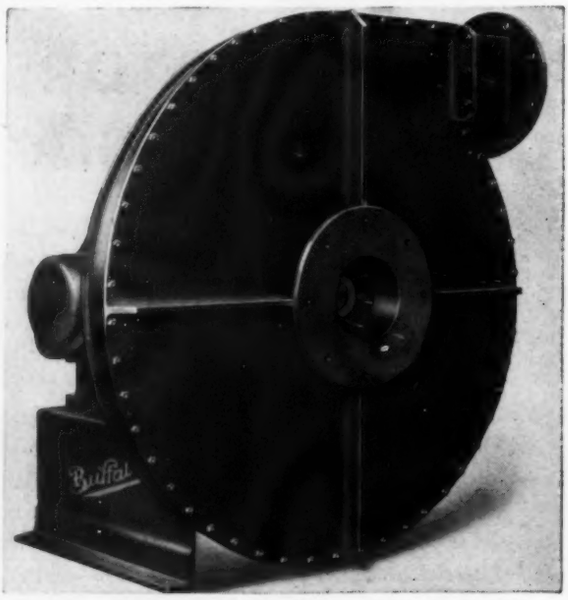
TRI/CLAD MOTORS

Buy all the BONDS you can—*and keep all you buy*

# What makes these fans *better?*



Discharge end of belted Buffalo Type "B" Vaneaxial Fan for static pressures up to 1½". A single tight streamlined belt fairing gives complete protection to belts. Removable rear cap gives easy access to belt sheaves.



Inlet side of Type "CB" Blower (for pressures from ¾ lb. to 2 pounds per square inch). Heavy plate welded construction. Entire inlet side is removable for access to rotors. (For higher pressures, up to 4 pounds per square inch, Type "CC" blowers are available, also described in Bulletin 3553.)

To begin with, the two fans shown here are new models, designed with modern fan requirements in mind, so that efficiency and economy of operation are both good.

Next, and more important, these two new fans are products of an engineering organization second to none in the fan industry — with more than 66 years of fan building experience behind it. These fans have the desirable features of a number of earlier designs, plus new advantages offered now for the first time.

If your requirements call for fans within the capacity and pressure range of either of these new models, you'll want to know all about them before you specify. Bulletin 3533 describes the new Type "B" Axial Flow Fans.

Bulletin 3553 gives full details of Type CB and CC Pressure Blowers.

**Buffalo Forge Company**

**173 Mortimer Street** **Buffalo, N. Y.**

**Canadian Blower & Forge Co., Ltd., Kitchener, Ont.**

"Buffalo" "First For Fans"

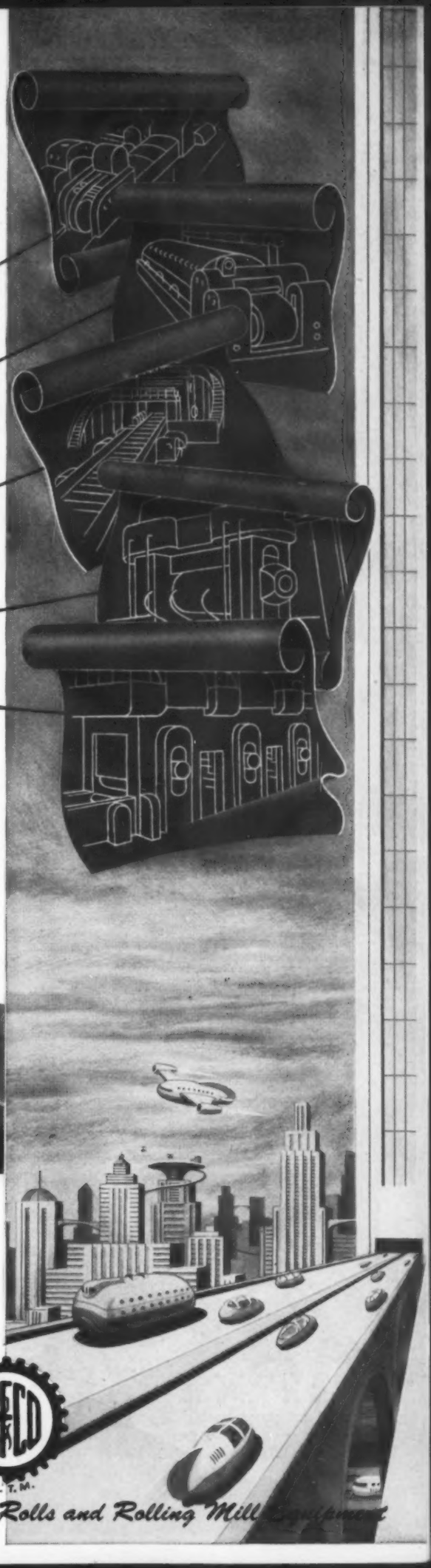
# fans *for* industry

**UNITED'S** engineers, outstanding contributors to the progress of the rolling industry for the past 40 years, are today engaged in developing improved processes and machinery to meet tomorrow's radically advanced and highly competitive manufacturing requirements.

Executives charged with reconversion to the economical processing of metals, rubber or synthetic resins, should investigate UNITED'S ability to serve them, whether their problem is the replacement of present worn-out equipment; the construction and installation of modern processes within their present plants; or the design and erection of completely new, fully equipped plants.

Thoroughly experienced engineering and research staffs plus the productive capacity of UNITED'S six great manufacturing organizations are at the service of the industry.

## shape of things to come



# UNITED Engineering and Foundry Co.

## Pittsburgh, Pennsylvania

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates:
Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P.Q. Canada

UE&FCO REG. T.M.

** The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

# 2-in-1 Substation Saves Mill Space

## A-C AND D-C LOADS SERVED BY COMPACT UNIT

A SUBSTATION tailor-made for steel mills having highly-concentrated and diversified loads, as shown in the artist's sketch below, is now offered by Allis-Chalmers.

Because it comprises a 2400 volt multi-circuit substation, an a-c load center substation, and a d-c load center substation in a single unit, it is called a "packaged" substation. This compact arrangement of switchgear and transformers saves valuable floor space ... installation time ... and operator's time.

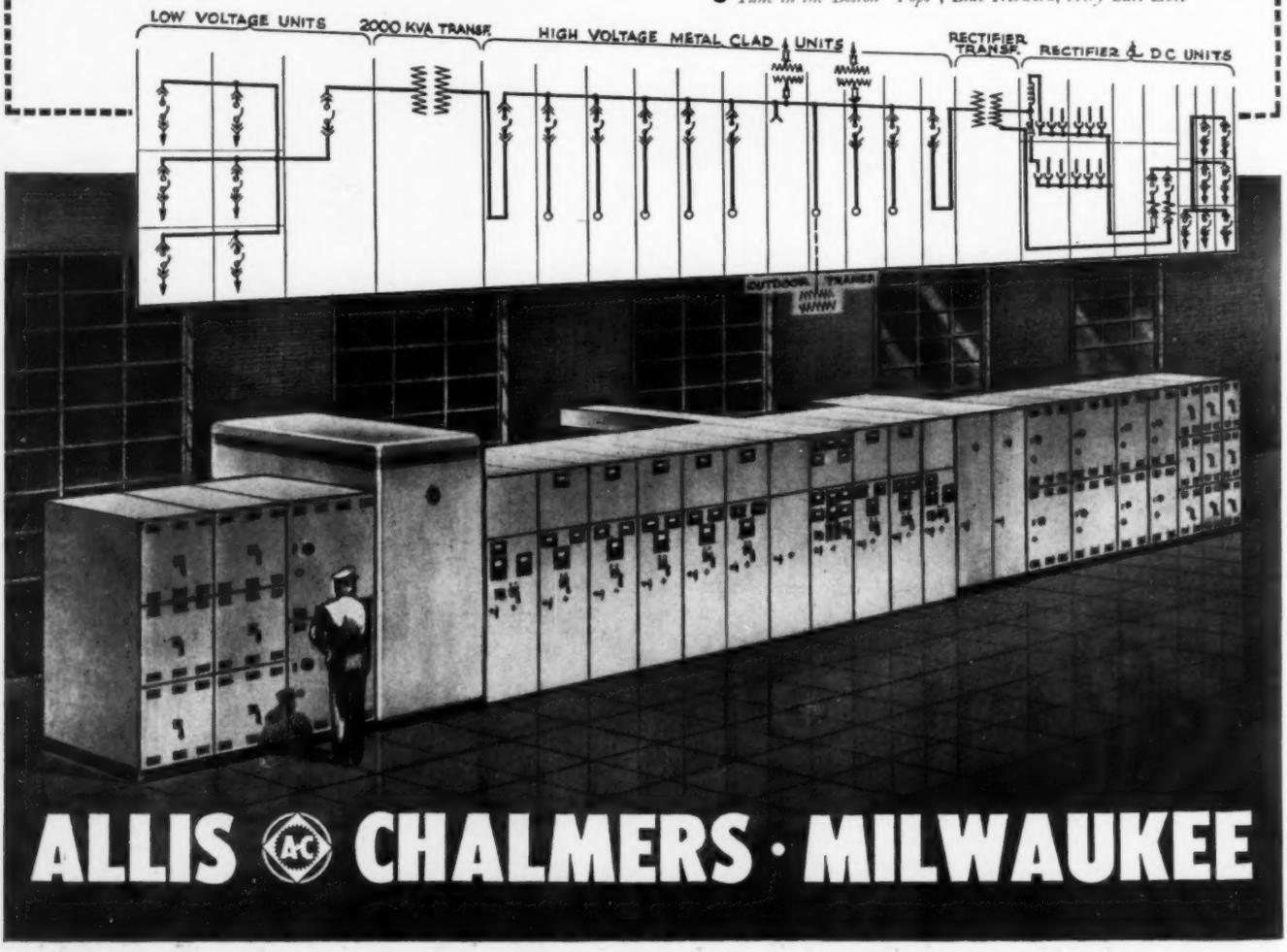
Through use of the new 2000 kva streamlined, dry-type transformer, and switchgear which contains "Ruptair" magnetic air circuit breakers, Allis-Chalmers has achieved a *totally oilless* metal-clad installation.

At the d-c end of the substation is a 500 kw rectifier — the *permanently-sealed Excitron* — which requires minimum maintenance.

For easy accessibility, both "Ruptair" circuit breakers and potential transformers are drawout in construction. Get further details on this modern substation from our nearby district office, or write direct to ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

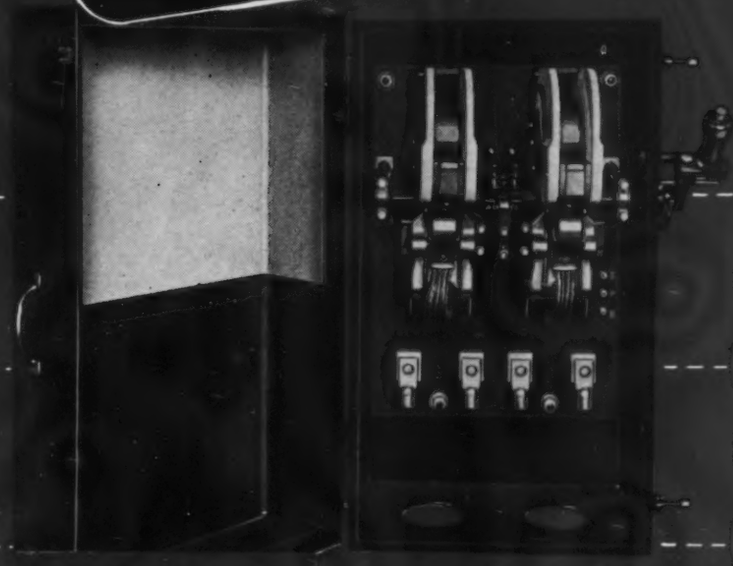
A 1867

♪ *Tune in the Boston "Pops", Blue Network, every Sat. Eve.*




ALLIS CHALMERS · MILWAUKEE

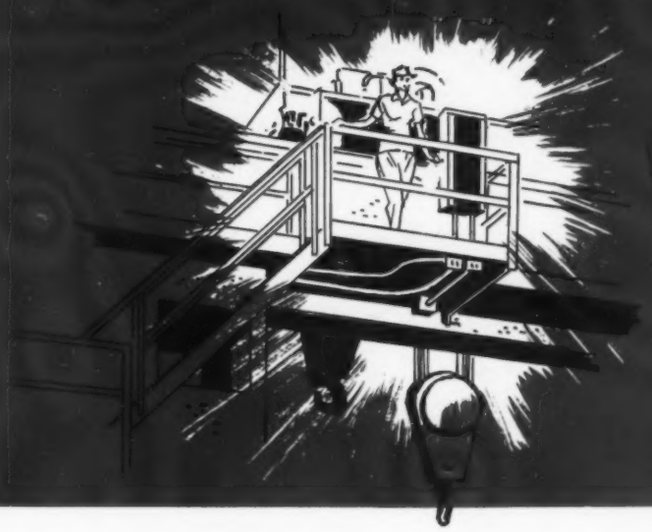
# new Safety Disconnect Switch for D-c Cranes



1 Manual-magnetic type for ease of operation.

2 LINE-ARC design for high arc-rupturing ability.

3 Designed with parts associated with crane control to reduce the replacement-part problem.



● Safety rules in many industrial plants and laws in several states require a safety disconnect switch on overhead traveling cranes, mounted at the point where the operator enters or leaves the crane. These switches disconnect the crane from the main collector power-feeders running along the crane runway.

Previously, operators, especially women, have had difficulty in opening and closing disconnect switches of the manually operated type.

This new EC&M *Magnetic Type* Disconnect Switch meets all the requirements of ease of operation, safety, convenience and reliability. It is of double pole design, completely enclosed and has side-type, externally-operated handle with thumb-latch which holds handle in either open or closed position. Pushing the handle up closes the switch, pulling it down opens it—a cam roller forces contacts open, if necessary, and also insures against accidental closure due to vibration or an impact blow from another crane on the same runway. It allows for up to three padlocks for locking switch open.

New publication 1024, just issued, gives complete data on ratings, sizes, dimensions, etc. Copy will be mailed promptly upon receipt of your request.

E&M

**THE ELECTRIC CONTROLLER & MANUFACTURING CO.**

2698 EAST 79th STREET • CLEVELAND 4, OHIO

# WILL THE SON of STOYAN HRUBA BE A BILLET-CHIPPER?

American-born . . . with the promise of an education and opportunities far beyond those offered Old Stoyan . . . this youngster can't be tagged for the unskilled labor group. He's going to clamber up to a better place for himself. Furthermore, there'll be no immigrant flood of his father's countrymen to take the hard jobs in the billet sheds.

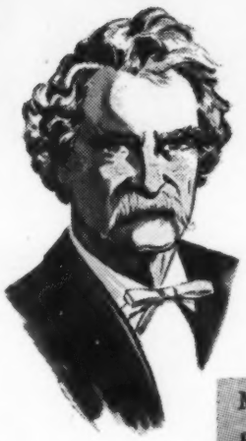
Do you, as a steel-maker, face a dilemma? Not if you act now to mechanize your billet conditioning! The Bonnot Billeteer, a completely mechanized chipping machine, does the work of 10 to 15 manual hammermen. Operation requires no great technical skill, but does give the worker an opportunity to take pride in his job.

Beyond human factors, critical as they are, there is an amazing reduction of billet conditioning costs, with impressive savings in salvaged heats where hand chipping is prohibitively expensive.

THE American Way is the Better Way. Engineering ingenuity will make possible a higher standard of living and a greater personal freedom.

*Need we urge you to write for information?*

Address correspondence to
**STEEL EQUIPMENT DIVISION**



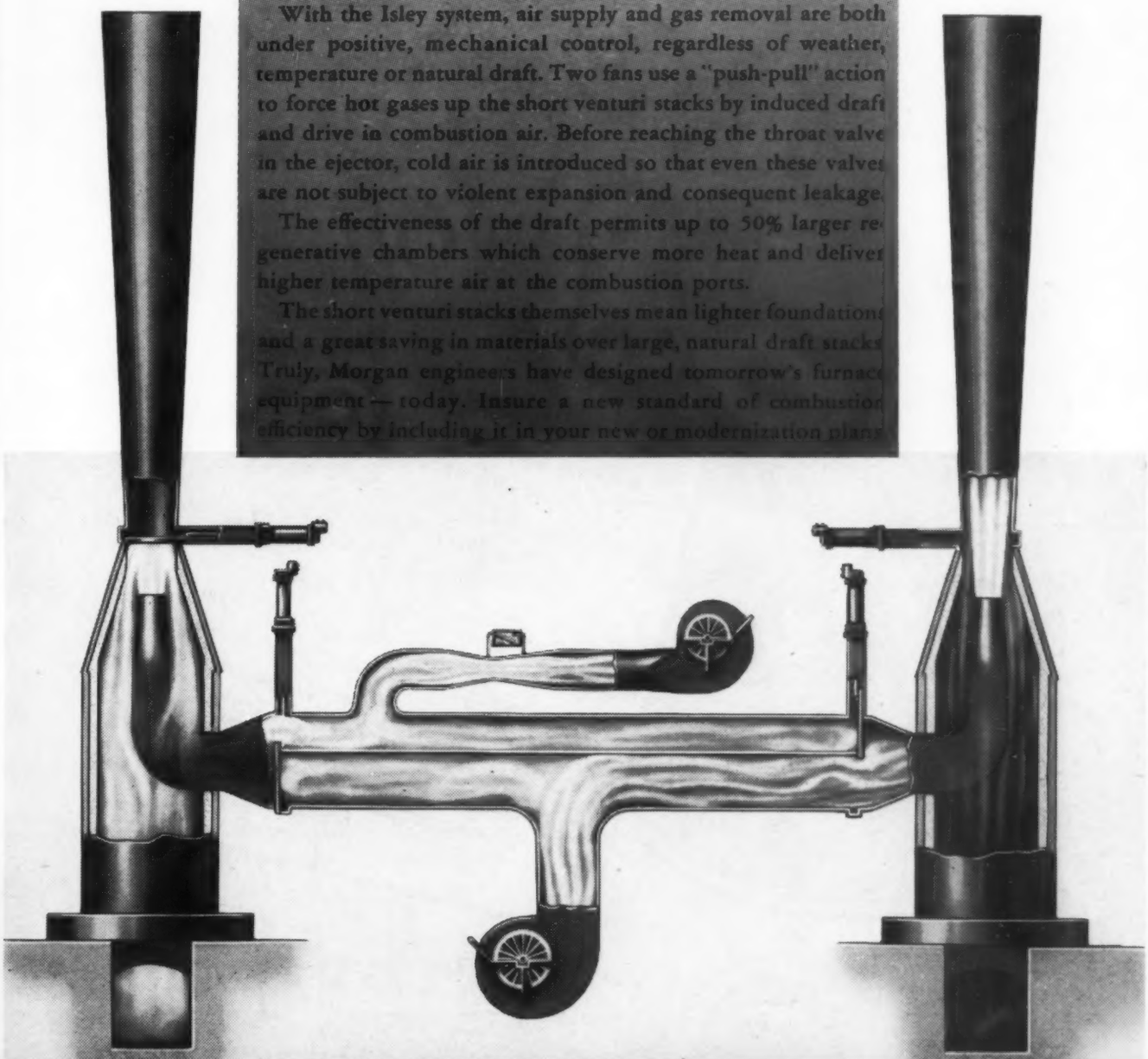
# "THE WEATHER IS ALWAYS DOING SOMETHING"

**Mark Twain had his facts straight there — just as Morgan engineers did when they designed the Isley Regenerative Combustion Control system. This is the industrial furnace control which makes its own weather — always maintains ideal conditions for maximum efficiency.**

**With the Isley system, air supply and gas removal are both under positive, mechanical control, regardless of weather, temperature or natural draft. Two fans use a "push-pull" action to force hot gases up the short venturi stacks by induced draft and drive in combustion air. Before reaching the throat valve in the ejector, cold air is introduced so that even these valves are not subject to violent expansion and consequent leakage.**

**The effectiveness of the draft permits up to 50% larger regenerative chambers which conserve more heat and deliver higher temperature air at the combustion ports.**

**The short venturi stacks themselves mean lighter foundations and a great saving in materials over large, natural draft stacks. Truly, Morgan engineers have designed tomorrow's furnace equipment — today. Insure a new standard of combustion efficiency by including it in your new or modernization plans.**



**MORGAN CONSTRUCTION COMPANY, Worcester, Massachusetts**

ENGLISH REPRESENTATIVE: INTERNATIONAL CONSTRUCTION CO., 56 KINGSWAY, LONDON, W.C. 2, ENGLAND

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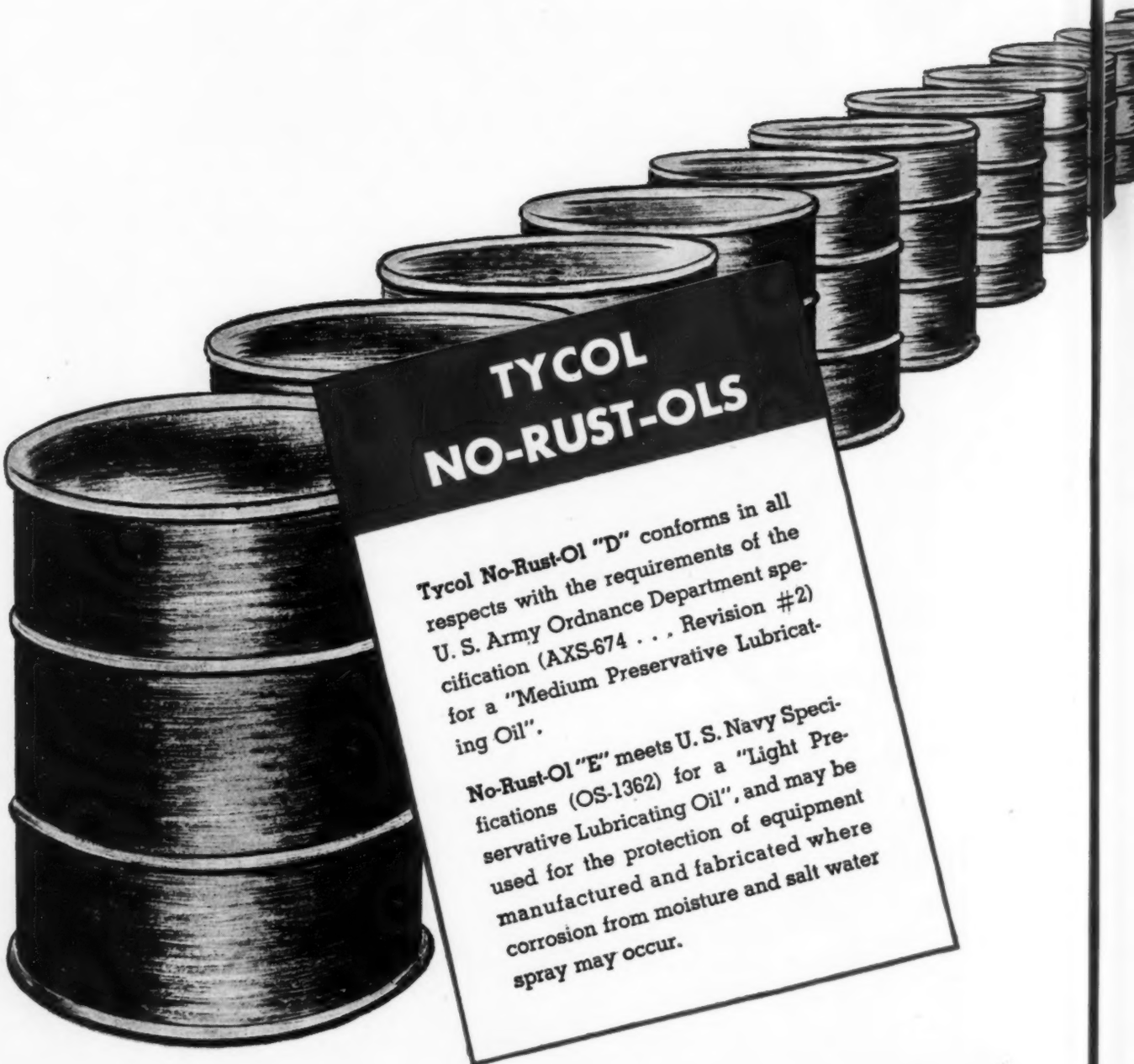
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Tycol No-Rust-Ol "D" conforms in all respects with the requirements of the U. S. Army Ordnance Department specification (AXS-674 . . . Revision #2) for a "Medium Preservative Lubricating Oil".
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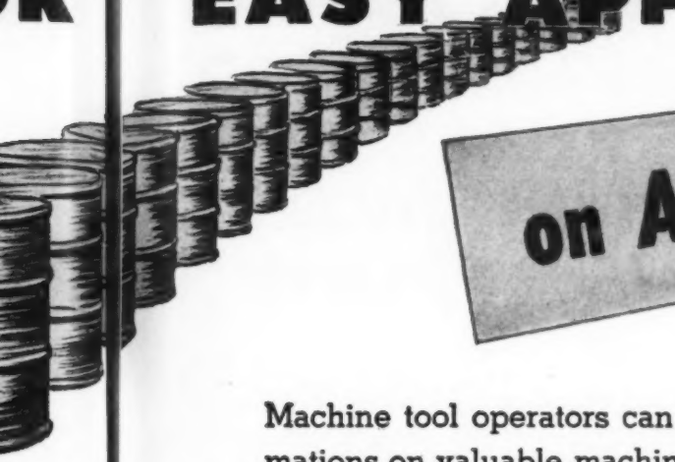

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Machine tool operators can now prevent or greatly reduce surface rust formations on valuable machines – small parts prior to assembly – and finished products – thanks to NEW Tycol No-Rust-Ols.

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# . . . and on the home-front

## B&W INSULATING FIREBRICK STOOD UP UNDER FIRE WITH "PRACTICALLY NO MAINTENANCE"

The year Poland was invaded, a mid-western foundry rebuilt its annealing furnaces.

That was a long time ago . . . when "Dunkerque" was only a provincial place-name. Before "Pearl Harbor" became a slogan and a challenge.

Throughout this whole period . . . since 1939 . . . these mid-western furnaces have operated continuously, on a 50-hour cycle, at a temperature of 1730 F. The B&W Insulating Firebrick installed in these furnaces the year Poland fell are still in service and according to the user, have required practically no maintenance.

This is just one of many examples of the low cost of B&W I.F.B. on a life-term or service-year basis.

Your local B&W Refractories Engineer will gladly give you other cost-reducing data on these remarkable firebrick.

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**85 LIBERTY ST., NEW YORK 6, N. Y.**

ARMY E NAVY

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BUY WAR BONDS! BUY MORE THAN BEFORE

R-201

# Crops *and* Shorts

AMIDST all the conversation about V-E day and V-J day, we would like to venture a suggestion that we have V-A day — V-A standing for Vigilance in America — vigilance to maintain what is left of true freedom and liberty, and to regain what has been filched away — vigilance to restore free, competitive enterprise, wherein initiative is recognized and energy rewarded. Let's celebrate V-A day everyday.

▲

RESULTS of a recent survey made by Dun and Bradstreet, Inc., show that, of 1449 concerns reporting in the iron and steel and allied industries, 38 per cent plan the postwar manufacture of new products, 34 per cent plan to sell new classes of customers, 44 per cent plan to expand their sales territories, and 22 per cent plan to use new methods or channels of distribution.

▲

IF it weren't for the fact that the Axis war criminals might take advantage of the tip, we might suggest that the best hiding place in the world would be in the office files.

▲

INFORMATION Circular 7315, published by the Bureau of Mines and prepared by H. Foster Bain, is titled "A Pattern for Western Steel Production." It states that postwar operation of new steel plants in the West will require recapitalization to eliminate excessive wartime costs, an aggressive marketing program to develop new outlets for steel, radical adjustments in freight rate structure, and technical developments to overcome undesirable characteristics in western ore and coal, as well as a possible deficiency in local scrap supply.

The study reaches the conclusions that raw materials are available in sufficient quantities, that their defects in quality can be overcome, and that assembly costs are reasonably competitive; that markets are adequate to support production in plants of economic size; and that with capable management, it should be possible to operate with competitive conversion costs.

▲

CUT-BACKS in the ship-building program are reflected in the return of much wide continuous mill capacity to the production of sheet material. Carnegie-Illinois Steel Corporation recently announced that its Irvin strip mill had ceased all plate production. Other plants have cut back in varying degrees.

▲

REMEMBER when the billboards were urging us to eat more bacon and eggs? Yep, there seemed to be a surplus — so much so that, under urging of government officers still trying to plan economy, pork production in 1944 was reduced 29 per cent under the 1943 level. The shortage resulting from this cut caused the beef supply to become more inadequate, which in turn ate into the poultry supply, until the absence of meat threatens to become as permanent as those signs "Temporarily out of cigarettes." Now a report released by War Food Administration estimates a United Nation shortage in 1945 of 6,200,000,000 lb of meat, part of which is to be made up by cutting back United States' meat consumption. In algebra we learned how to subtract something from zero, but when it comes to cutting back from no steak, no roasts — anyway, the whole situation affects us much the same as a chair with broken springs.

▲

IN the past four years the steel industry's sales volume has practically doubled, while earnings declined from $330,000,000 (1941) to less than $200,000,000 in 1944.

▲

ALTHOUGH we are blissfully ignorant about female fashions, observation leads us to believe, in spite of assurances to the contrary, that women's slacks are usually made from broad cloth.

▲

FUEL costs have decreased at the rate of about one per cent per year for the past 20 years, according to M. J. Conway of Lukens Steel Company in an address before the A. S. M. E. in New York.

▲

RECENTLY discovered iron ore reserves in Labrador are being developed. These deposits, which are said to be quite extensive, are similar to Lake Superior ores and average 62 per cent combined iron and manganese, principally of Bessemer quality.

▲

THE British iron and steel industry is looking forward to a wholesale rebuilding of obsolete plants and a general rehabilitation of existing equipment.

▲

ELBERT HUBBARD once said "Advertising is the education of the public as to who you are, where you are, and what you have to offer in the way of skill, talent, or commodity. The only man who should not advertise is the one who has nothing to offer the world in the way of commodity or service."

# GREATEST ADVANCE IN CRANE DESIGN IN 20 YEARS!

## NEW CAB PROVIDES FULL VISION— SIT-DOWN CONTROL—AIR CONDITIONING

Again Cleveland Crane scores another *first* in crane design—the greatest step forward in crane construction since the advent of the all-welded steel crane also pioneered by Cleveland Crane 20 years ago—a new cab that is radically different in every respect.

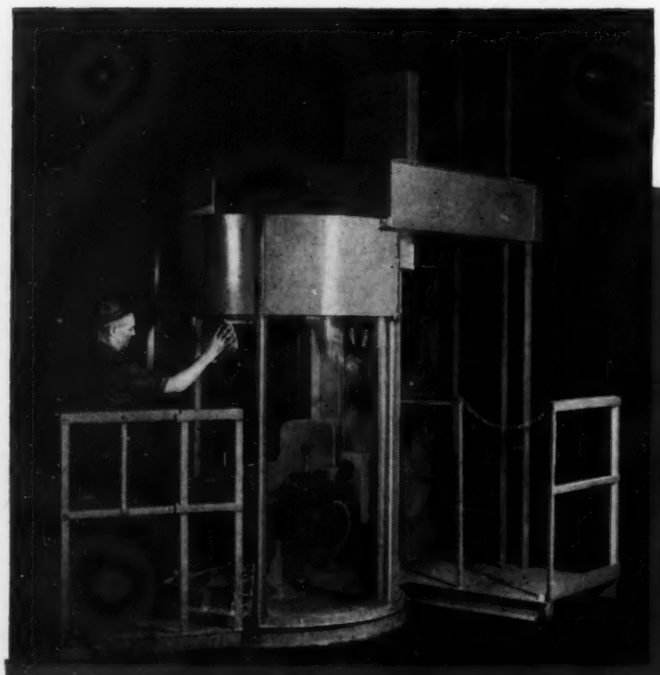
Modern, streamlined in appearance, the cylindrical-shaped cab provides full vision for the operator, comfortable sit-down control and air-conditioning.

Shatter-proof plastic enclosure panels extend to the floor permitting maximum vision in every direction over the area covered by the crane. Corners or blind-vision spots are eliminated.

Crane operation with this cab is a simple easy sit-down job. Hoist and trolley master switches are attached to the chair arms for manual operation; bridge switch and hydraulic brake are secured to the floor for foot operation. Each of the operator's limbs has one definite control job—no double duty.

An air-cooled, air-conditioning unit especially developed for this cab provides fresh clean air at any normal temperature desired and gives protection against objectionable gasses, dusts and fumes.

This new cab is a self-contained unit that may be furnished with any new crane or easily applied to existing cranes of any make employing magnetic control.



WINDOWS EASILY CLEANED

A novel traveling platform serves both as vestibule to the cab and means for easy access to the entire exterior window surface for cleaning purposes. Safety locks on both platform and cab door prevent operation of either except when platform is at

### Features Plus

1 Maximum vision in all directions. No corners. No blind spots.

2 Operator sits in comfortable adjustable seat.

3 Easy control arrangement. Each of operator's hands and feet have definite job—but no double duty.

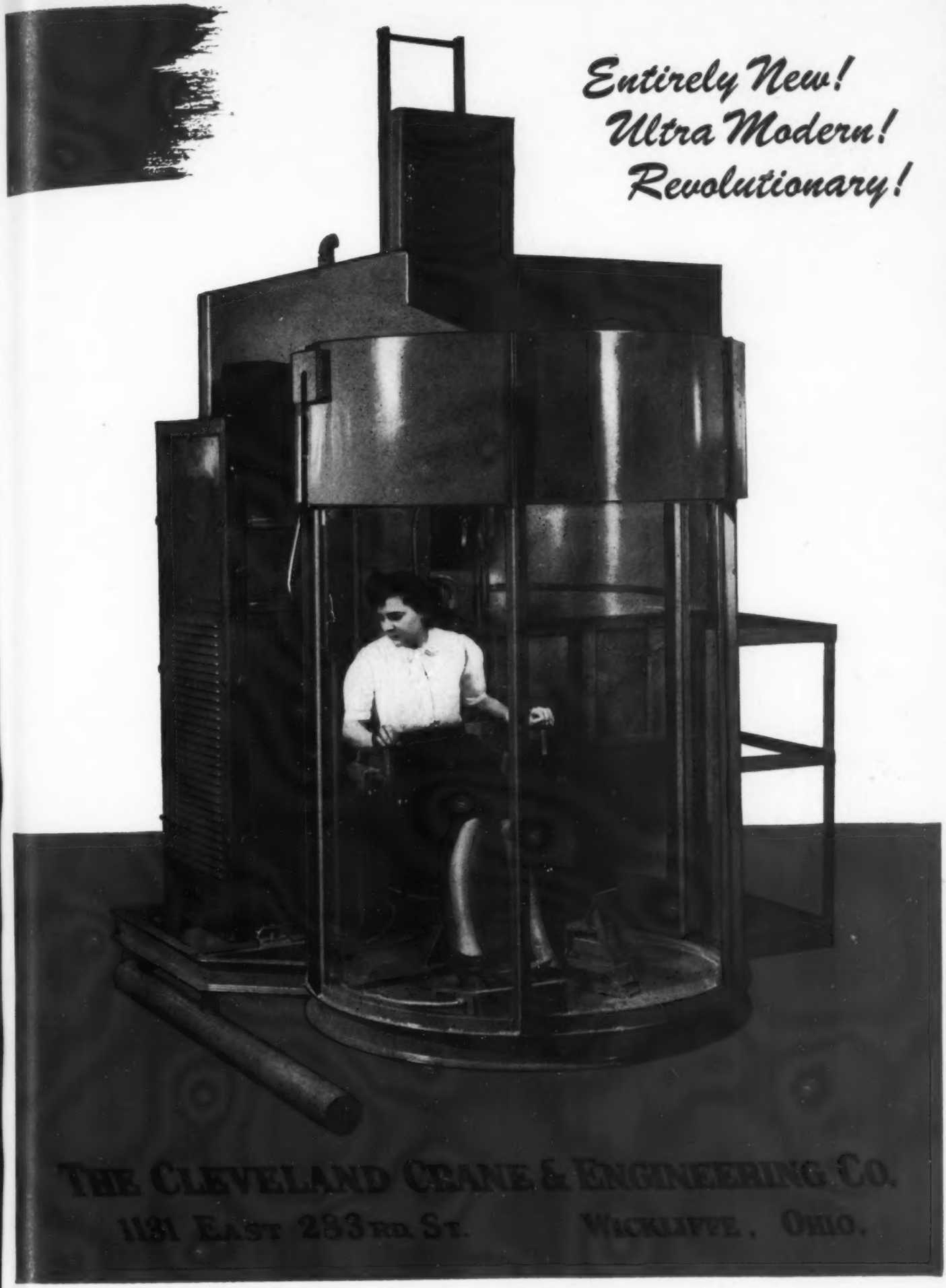
4 Fresh, clean air, cooled to temperature desired. (Air conditioning unit for cab illustrated suitable for temperatures up to 140°).

5 Full protection against gasses, dusts and fumes.

6 Windows easily cleaned by means of traveling platform.

7 Compact self-contained unit complete with controls, brake and air-conditioning equipment.

8 Easily applied to new or existing cranes of any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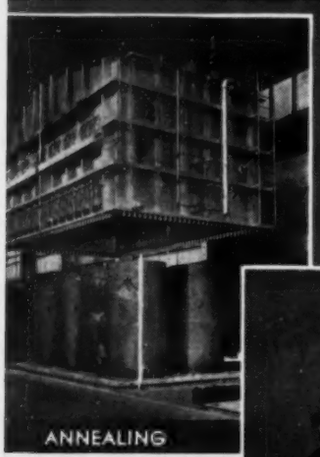
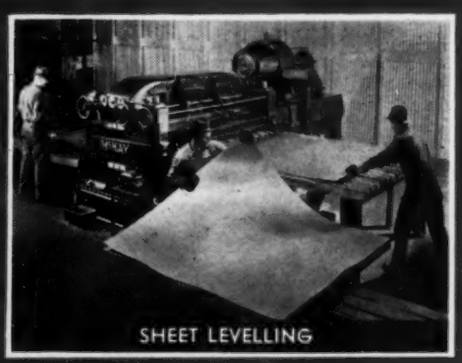


ANNEALING

SHEARING



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- Corrugated Inner Covers
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- Wheelabrator Abrasive Cleaning Equipment
- Automatic Weight Classifier
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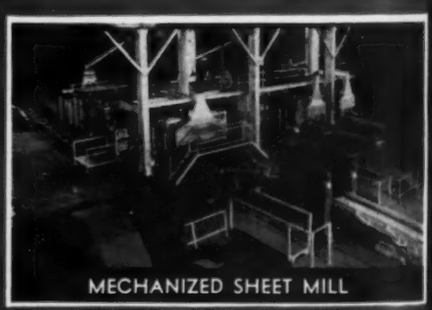
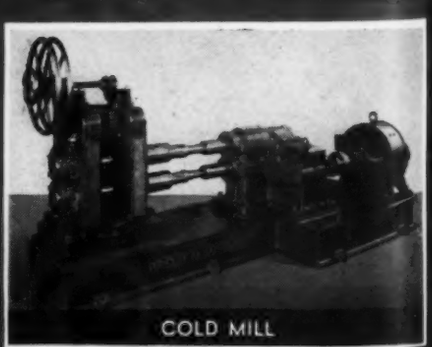
- Shell Lathes
- Airplane Motor Sleeve Lathes
- Armor Plate Levellers
- Vacuum Cup Lifters
- Electrolytic Tinning and Galvanizing Equipment
- Narrow Strip and Wire Mill Machinery



MECHANIZED SHEET MILL



COLD MILL

**SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT**

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MAY 1945 VOL. XXII NO. V


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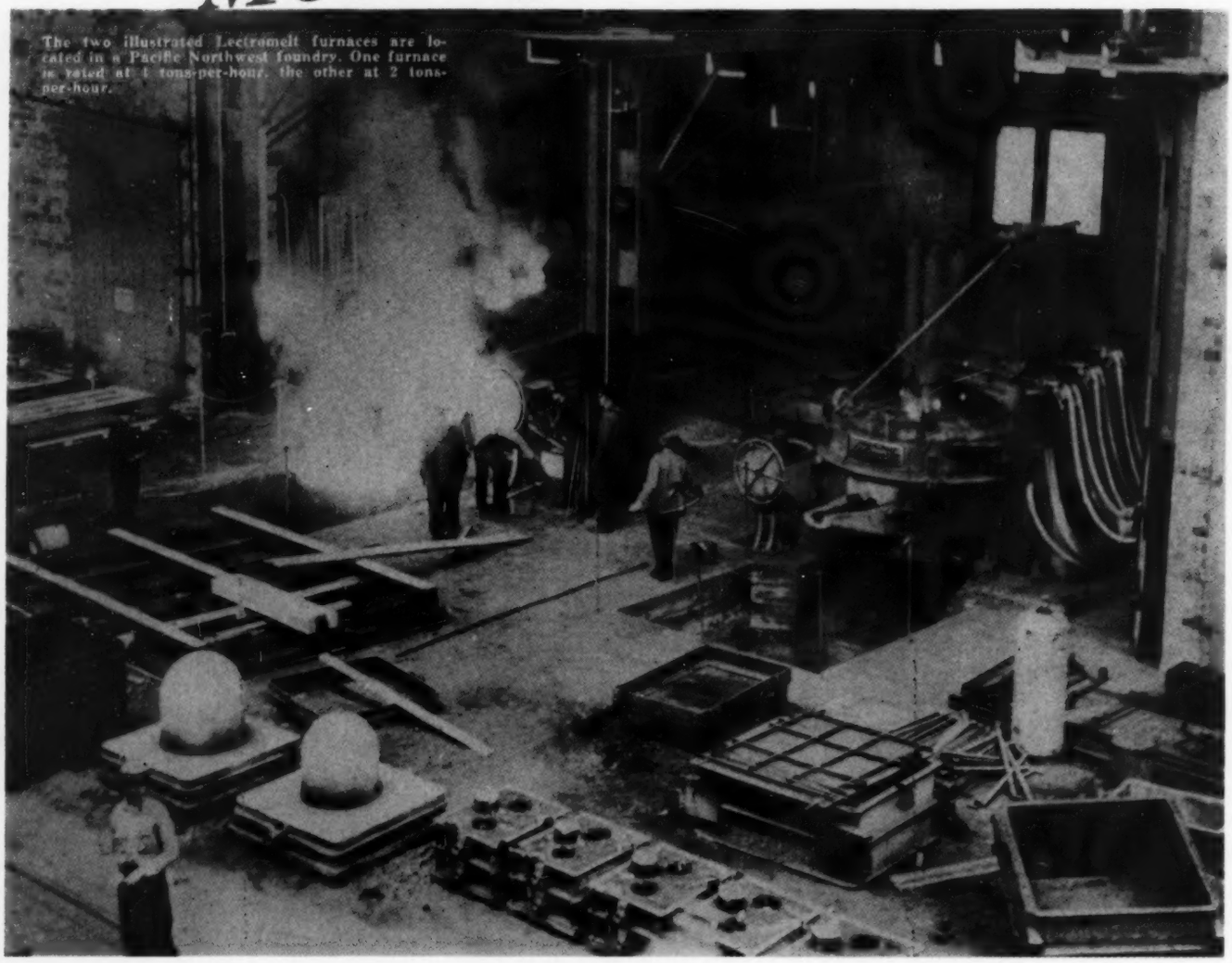
# For Increased Melting Capacity



The two illustrated Lectromelt furnaces are located in a Pacific Northwest foundry. One furnace is rated at 1 tons-per-hour, the other at 2 tons-per-hour.

★Standard Lectromelt furnaces customarily melt down their rated capacity of cold charge within one hour's time when operating on single slag basic practice or on acid practice. Most Lectromelt furnaces have poured heats considerably in excess of their rated hourly capacities to meet special requirements, when necessary. In addition, the top-charge feature permits quick charging by means of drop-bottom bucket, thus losing little time between heats.

Increased production demands for quality steels and irons are readily met by Lectromelt users. Write for information about our top-charge furnaces, available in sizes ranging from 100 tons down to 250 pounds.

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PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH 30, PENNA.

# DESIGN AND OPERATION OF

# *Modern Sintering Plants*

*. . . . although sintering is not an innovation, the process received great impetus in recent years as a means of increasing blast furnace production . . . . the design of the new plants shows many improvements, particularly in the material handling facilities . . . .*

*by* **C. J. DUBY,** CHIEF ENGINEER
REPUBLIC STEEL CORPORATION
WARREN, OHIO

To aid the war effort the expansion program for the steel industry, as sponsored by the War Production Board, included sintering plants at various locations throughout the country having an approximate capacity of 10,771,000 net tons annually. It was felt that with this tonnage of sinter the output of the existing blast furnaces could be increased approximately 851,000 net tons of pig iron annually, which would be the equivalent of approximately two additional blast furnaces.

In this expansion program Republic Steel Corporation was called upon to build five sintering plants for the Defense Plant Corporation, with a total rated capacity of 2,189,000 net tons per year. These plants were to be located in the following districts and to be designed to sinter local materials with annual capacities as noted:

| | |
|---|---|
| Spaulding, Alabama — Hematite concentrates and flue dust, one machine, 16 wind boxes | 350,000 tons |
| Port Henry, New York — Magnetite concentrates, two machines, each 14 wind boxes | 765,000 tons |
| Warren, Ohio — Screened ore and flue dust, one machine, 12 wind boxes | 382,000 tons |
| Youngstown, Ohio — Screened ore and flue dust, one machine, 12 wind boxes | 392,000 tons |
| Chicago, Illinois — Screened ore and flue dust, one machine, 12 wind boxes | 300,000 tons |
| Total | 2,189,000 tons |

The type of sintering machine decided upon for these installations was that which is commonly known as the continuous pallet conveyor with ignition furnace over the bed. It was found that various ores and ores of various screened sizes have definite sintering characteristics, and these facts were considered in determining the square feet of effective wind box area and the size, type and capacity of the suction fan required for the individual plants to meet their local conditions.

Wind boxes, down legs, collecting mains, dust catchers and dampers were designed to assure the minimum of resistance and turbulence to the flow of waste gases. The dust catcher or settling chamber was designed with a generous factor and should prove very effective and operate with very little attention and maintenance cost. All of these new sintering plants

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

have the same basic design mechanically; however, due to their particular locations in the various districts and the existing methods that were at hand for handling raw materials, special consideration had to be given to the raw material conveying system as well as the storage bins, track hoppers and screening equipment, and also the discharge of the finished sinter and subsequent handling.

The ores from the Port Henry mine located near Lake Champlain in New York lend themselves admirably to concentration and sintering to produce excellent open hearth charge ore and blast furnace sinter. Past experience has proven that by charging sinter in the blast furnace burden to as much as 40 or 45 per cent of the metallic charge, pig iron production could be raised 10-19 per cent, coke consumption decreased approximately 15 per cent, flux lowered approximately 20 per cent, and flue dust production cut down as much as 50 per cent. These figures, of course, are only approximate and vary with the different furnaces.

The design and operation of sintering plants has been the subject of much engineering concern in the industry and in numerous cases poor results were obtained from earlier plants. A continuous pallet conveyor type sintering plant has been in successful operation at the Corrigan-McKinney plant of the Republic Steel Corporation in Cleveland, Ohio, for a number of years. This plant was used as a guide in designing the five new sintering plants for the corporation. In designing sintering plants in connection with blast furnace plants, careful consideration should be given to the amount of flue dust that will be produced. Of course, this depends upon the number of blast furnaces in the location. In addition to flue dust, consideration should also be given to sintering fine ores. The flue dust usually contains excess carbon in the form of fine coke, and this excess carbon is ideal for sintering fine ores which give the operator a means of balancing carbon content in the feed to the sintering machine, thereby securing uniformity of product. The percentage of ore added to the mix to balance the excess carbon in the flue dust increases the tonnage output by the percentage of ore added over the tonnage that could be made by flue dust alone. All blast furnace plants usually have quantities of fine ore of which a good percentage will flow out as flue dust if charged into the furnace. Therefore, some of this ore should be made available for processing in the sintering plant.

The handling of blast furnace sludge, which accounts for 30-50 per cent of the flue dust produced, should be given careful consideration. Sludge is not a desirable sintering material as it is very fine and has a high moisture content, but if properly handled it can be added to the other sintering component materials without difficulty. The usual methods of recovery are through underflow thickeners or settling basins. At some plants the sludge is pumped to a filter where a filter cake of uniform moisture content is produced. The filter should be located at the sintering plant where the filter cake may be discharged directly onto a conveyor carrying the mixture to be sintered. Filter cake handled in cars presents many handling problems through track hoppers, chutes, bins, etc. Sludge taken to the ore yard, where it is mixed with flue dust or ore, produces a very unsatisfactory material for the sintering plant due to the variations in carbon and moisture.

In designing the plants care was taken to minimize the amount of dust in the building, and very close study was made of ways and means to combat the dust problem in electrical and mechanical equipment. The electrical interlocking of the various conveyors, feeders and other equipment was given careful attention, as the time delay in operation that could occur if material continued to feed onto a stopped conveyor belt could easily be many times the delay that would occur from a minor electrical or mechanical failure that would automatically stop all preceding conveying and feeding operations.

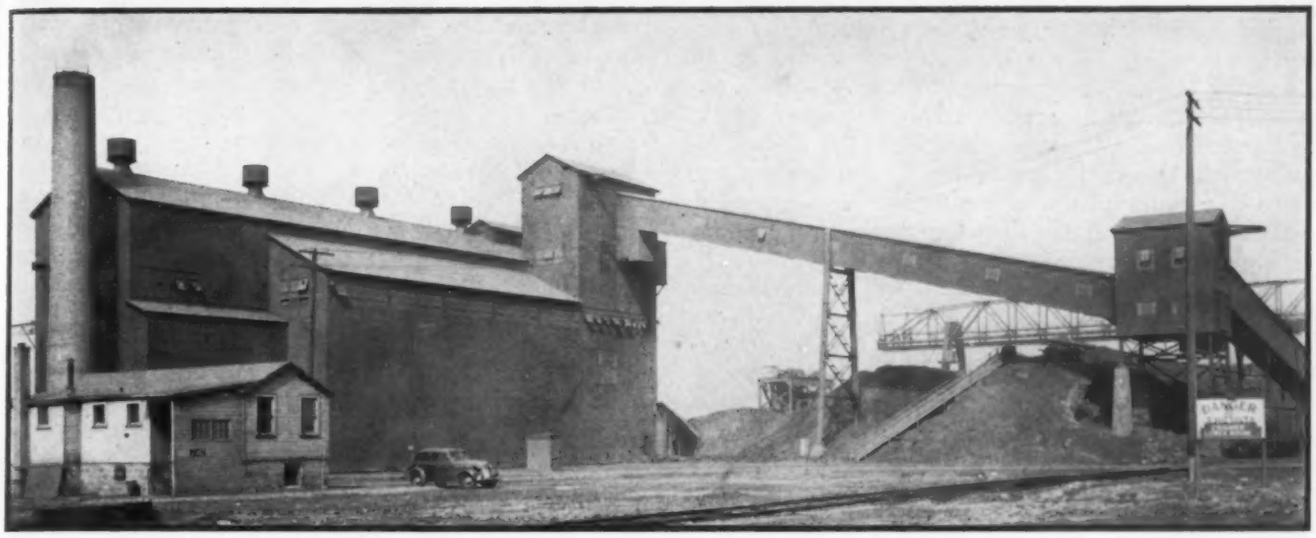
The raw material bin system and the automatic feeding of the material to the system was given careful attention to be certain that a sufficient amount of each raw material could be kept on hand at all times to insure continuous operation once a run was started.

At the Warren plant ore or flue dust to be sintered is loaded into the ore larry car by the ore bridge and the larry car then deposits the material into one of four track hoppers, each having a capacity of 2,035 cu ft. Each track hopper has two syntron electronic bin feeders that dump onto a belt conveyor that is common for all eight feeders. This track hopper conveyor, or conveyor A, is a 30 in. wide belt running 236 fpm and is approximately 40 ft long.

From the track hopper conveyor the materials are delivered to the sintering plant on two inclined belt conveyors, No. 1 and No. 2, to a point in the sintering building 78 ft 5 in. above yard level. No. 1 conveyor, which is 30 in. wide, travels at a rate of 260 fpm. This conveyor is horizontal for 84 feet and then it is inclined at an angle of 7° 7′ 30″ to a height of 43 ft above yard level, terminating in a junction house which is 406 ft from the center line of the track hoppers. The junction house is a steel building approximately 20 ft by 20 ft with corrugated steel siding and roof. Materials from conveyor No. 1 are discharged onto conveyor No. 2 in the junction house. Conveyor No. 2 is also a 30 in. wide belt traveling 260 fpm and is inclined to the sintering building at an angle of 13° 45′ 18″, is approximately 184 ft long and discharges the materials into the screen house which is located in the top floor of the sintering building. Both of these conveyors are located in enclosed galleries of steel construction with corrugated steel siding and roofing, with man ways provided the entire length of the conveyors.

The materials discharge from conveyor No. 2 into a chute with two down legs, one for each of two screens. The screens are single-deck shaking units 60 in. wide by 120 in. long with ¼ in. stroke and ⅜ in. by 3 in. screen cloth. The screened material falls into a hopper that has its discharge end over tripper conveyor No. 3, and the oversize material is directed to an oversize chute and from there to the sinter pile in the ore yard.

Tripper conveyor No. 3 is also a 30 in. wide belt with a speed of 260 fpm. The tripper is a self-propelled car with a travel of 82 ft and can be positioned on any one of five storage bins, each having a capacity of 6,530 cu ft. Normally these bins are loaded one with coke breeze, one with fine ore, and three with flue dust. All conveyors up to the storage bins are designed to handle 400 tons of material per hour, so that filling of the



**This sintering plant at the Warren, Ohio, plant of Republic Steel Corporation has a capacity of 382,000 tons of sinter per year, operating on flue dust and fine ore screenings.**

storage bins can be done on the day shift. All conveyors from the storage bins to the sintering machine are designed for 75 tons per hour.

The bottom of each of the storage bins is built into a circular section 5 ft in diameter, terminating directly over the feed table of a disc feeder. Diameter of the feed table is 6 ft 11¼ in. inside. The disc feeder tables can be rotated at speeds from 1.5 to 4.5 rpm, and each is driven by a 5 hp, 500-1500 rpm, totally enclosed fan-cooled motor.

All five disc feeders discharge material at a predetermined rate from their respective storage bins onto No. 4 conveyor, which is a 24 in. wide belt traveling at 260 fpm. The materials are then delivered onto conveyor No. 5, which is also a 24 in. wide belt traveling at 260 fpm. No. 5 conveyor delivers onto No. 6 conveyor, which runs lengthwise of the sintering building at an inclination of 17 deg 40 ft 34 in. and is 154 ft long. This conveyor is a 24 in. wide belt traveling at 260 fpm and delivers the material into one or the other of two double shaft pug mills.

After going through the pug mills the material is delivered to a swinging spout over the sintering machine on conveyor No. 7, which is a 24 in. wide belt traveling at 260 fpm. The swinging spout is motor driven and spreads the material uniformly across the grates at the feed end of the sintering machine.

The sintering machine is a continuous pallet conveyor and is 72 in. wide and 89 ft 1½ in. long from center line of drive shaft to center line of the discharge end radius, having an adjustable speed from 40.8 in. to 122.4 in. per minute. The pallets and pallet frames are made of steel castings and are supported on forged steel track wheels equipped with roller bearings, closures and alemite lubricating fittings. The entire conveyor is well sealed. Careful consideration was given to the design of the entire machine to insure proper lubrication and sealing.

Underneath the sintering machine there are twelve wind boxes, each 5 ft 9 in. wide and 6 ft 2¼ in. long, made of cast iron. The wind boxes are on 6 ft 4½ in. centers and are connected to a rectangular suction main that is 7 ft wide by 2 ft 7⅜ in. high at the discharge end and increases to 9 ft high at the drive end of the machine. The suction main under the machine is equipped with six dust hoppers which have counterweighted gates on the hopper discharge pipes. When sufficient dust accumulates in the hopper, the weight of the dust opens the gate and the dust is discharged onto an 18 in. wide belt conveyor No. 8. Ahead of the main dust catcher there are three more openings in the main suction main that also discharge directly onto conveyor No. 8. The dust catcher is 12 ft inside diameter and 18 ft high with its discharge pipe also returning the trapped dust to conveyor No. 8. The sintering fan is connected to the discharge of the dust catcher by a 6 ft inside diameter pipe. The fan is a double inlet type, rated capacity 100,000 cfm at 24 in. static pressure, made of steel plate construction for 250 F, equipped with roller bearings and water cooled bearing housings, and is driven by a 600 hp, 720 rpm, 2,300 volt, 60 cycle, 3 phase synchronous motor with an exciter.

As previously mentioned all the dust from the dust catching hoppers is automatically discharged onto No. 8 conveyor, which in turn discharges onto No. 5 conveyor carrying the raw material to the sintering machine, and in this manner the dust is returned to the sintering machine.

The successful operation of the sintering machine depends upon the proper design of the ignition furnace which ignites the bed of material to be sintered and the proper suction of the sintering fan for maintaining combustion until the sintering operation is completed. Ignition furnaces have been made in the past with a spread of about 12 in. on the bed and the furnace temperature had to be raised to very high values to ignite the bed. The furnace has a flame spread of 84 in., which is 1 in. per inch of travel with the machine traveling 84 in. per min. This gives an ignition time of 1 min. and has proved very satisfactory. The furnace at Warren is coke oven gas fired.

The production of the sintering machine falls down

a grizzley chute, under which is a return fines bin having a capacity of 1,850 cu ft. This screen is made up of 6 in. by 1¼ in. bars standing on edge, spaced 1½ in. apart. The fines are thus removed from the sinter before discharging to the stock pile in the ore yard where it can be picked up by the ore bridge. The sinter fines are discharged from return fines hopper by vibrating feeder onto conveyor No. 6 and thence returned to the sinter machine for reprocessing.

From the foregoing description it will be noted that an attempt was made to do everything possible to make the plant continuous in operation. The storage bins can be filled during the day turn and the sintering plant will then have ample stock of raw material to continue operation for the remainder of the 24-hour period. Dust from the various collectors is returned to the sintering machine and sinter material too fine for the blast furnace is also returned to the machine for another sintering operation.

Careful consideration was also given to obtaining proper electrical equipment for the plant. All motor starters are oil immersed and are located in an all-welded steel control room which is ventilated by being connected to the filtered air system. All cooling air going into the sintering fan motor room is filtered through a 17,200 cfm capacity traveling screen air filter and then discharged into the motor room by a 12,000 cfm fan, which also serves the room housing the motor starters. The conveyor system controls for the conveyors up to the storage bins are centralized on a panel located at the top of the storage bins. The conveyor system in the plant proper is controlled from a panel adjacent to the head of the sintering machine.

For communication between the track hoppers and the filling stations for the storage bins, and the storage bin feeders and the main control station, mine type dust proof telephones were installed for reliability and simplicity.

From the foregoing description, it can readily be seen that the design is compact and so arranged as to allow for flexibility and variable control. With a reasonable degree of attention to the operating practice, these plants will produce a good quality of sinter with but little maintenance.

# DISCUSSION

PRESENTED BY


**C. E. AGNEW, Consultant, Blast Furnace and Sintering Plant Operations, Shaker Heights, Ohio**

**M. F. MORGAN, Arthur G. McKee & Company, Cleveland, Ohio**

**G. M. KYLE, Mechanical Foreman, American Steel & Wire Company, Donora, Pennsylvania**

**C. J. DUBY, Chief Engineer, Warren District, Republic Steel Corporation, Warren, Ohio**


**C. E. Agnew:** Mr. Duby has presented an interesting paper in which he has very clearly described the construction and operation of the conventional sintering plant. His description of the handling of the sludge from the gas washer discharge water is of special interest. The sludge handling problem is usually an aggravating one at most blast furnace plants and the location of the sludge filter at the sintering plant, and the direct feeding of the sludge into the sintering mix, appears to be an ideal solution of the problem.

Where such construction is not practical the handling of the sludge is a problem. In my own experience the sludge has been pugged with hot dust at the blast furnace dust catcher. The best that can be said is we got away with it. The pug mill used was a double shaft fluffing mill and the sludge had a tendency to ball into pellets from a top size of approximately 1¼ in. down to ¼ in. and the larger sizes of pellets would retain so much moisture that when introduced into the sintering mix they would only dry out the first time over the sintering hearth. At the discharge end of the machine the dried dust would pass through the grid bars with the return material and would be sintered on the second trip over the hearth. I have since seen dry dust pugged with sludge through a single shaft mill and the rubbing action of the single blade upon the material in the bottom of the mill appeared to overcome the tendency to ball which occurred in the double shaft fluffing type of mill. Where it is possible to install the equipment for pugging the hot dust and the sludge at the furnace dust catcher I believe a single shaft pug mill would deliver a material in good feeding condition. The silver lining of the sludge problem is that with a full burden of good sinter the production of sludge ceases to be a problem. Some years ago at an eastern plant, for a time during a slow blowing period, the use of both the thickener and the filter were discontinued because the amount of sludge recovered did not justify the operating cost of the equipment. Normally, with the full sinter burden the thickener concentrate was pumped to a settling basin which required cleaning only occasionally, rather than operate the filter which required closer attention. With the full sinter burden the production of sludge ceased to be a problem.

Mr. Duby points out that the material handling ahead of the feed storage bins varies with each plant. The problems governing the flow from the feed bins through the plant are, however, virtually the same in any sintering plant. Without any desire to appear critical I would like to follow that flow through the plant and present a viewpoint in some respects different from that presented by Mr. Duby.

As described, the disc feeders are driven by individual motors. They are of variable speed and I assume they are controlled by a master rheostat located on the control board at the head end of the sintering machine. The uniformity in percentages of materials, particularly if ores of different chemical analyses are being blended, is of sufficient importance that all feeders should operate at exactly the same speed. A line shaft powered by a single motor does this admirably and for the advantage gained the installation cost of the line shaft seems to be justified.

As described, the return material is fed directly onto the No. 6 belt as that belt conveys the raw materials past the return hopper. While this method of handling the return material is the more common practice, the

opinion is offered that a pug mill located so that the raw stock and the hot return material can be fed into it for preliminary pugging offers advantages which the direct feeding does not have. The physical heat of the return material is the only means of overcoming excess moisture and when natural ores are being sintered, particularly in wet weather, this heat is vital to the success of the operation. At any time the preliminary pugging of the hot return material and the cold raw stock kills the excess heat of the return material and consequently lengthens the life of the conveying belt. For these reasons the opinion is offered that the cost of a preliminary pug mill at the location stated is fully justified.

As described, the raw materials after pugging are delivered directly to the swinging spout. While it is always desirable to have as few working parts as possible, the opinion is offered that a small surge bin, equipped with a feeder, located between the pug mill and the swinging spout, is well justified. While in theory a continuous flow of materials can be maintained it is not so easy in practice. Any material having natural adhesiveness will at times build up in transfer chutes or in the pug mill, and the occasional release of such accumulations of stock will cause an excess of material to be delivered to the sintering hearth. This excess tends to cause the bed to pack and the benefit of the fluffing action of the pug mill is lost for that part of the bed which is packed. For the reasons advanced I believe a surge bin located between the pug mill and the swinging spout is desirable.

As described, the dust from the suction main and dust catcher is delivered to a belt through counterweighted gates which work automatically. This belt discharges the dust onto the belt which carries the raw stock to the sintering machine. The amount of this dust produced is a variable and therefore, if fed directly, the amount fed will be irregular. Under operating conditions it is at times desirable to stop the machine for a few minutes without stopping the fan and at all times when the plant is being shut down it is desirable to permit the fan to run for fifteen to twenty minutes after the machine and feed flow have been stopped in order to sinter the material on the hearth. The production of dust will continue so long as the fan is operating and with the main feed belt stopped there is certain to be spillage of dust. For this reason it is believed a small surge bin equipped with a feeder, located between the discharge end of the dust belt and the main feed belt, is also desirable. The two surge bins mentioned need not be expensive and they assure uniformity in the rate of feed flow.

Mr. Duby spoke of the sintering characteristics of various materials. So far as the sintering action is concerned, I believe the properties of particle size and adhesiveness are the most important. For example, the amount of dust pulled through the grates will be greater from a magnetite concentrate operation than it will be from a soft hematite ore operation. Blast furnace flue dust and granular hematites may be said to be somewhere between the two. In my experience, when using a mixture of soft hematite and hard magnetite concentrates, it was necessary to sand blast the fan blades about once a year to remove encrusted ore. This practice continued for about five years but in one year of straight magnetite concentrate practice the fan blades had to be replaced because of the abrasive action from the solids entrained in the waste gas. This experience is cited to emphasize the thought that a dust collecting system which may be necessary for one class of materials is not always necessary for other materials.

Mr. Duby described the ignition furnace as having a flame spread of 84 in. This is a great improvement over the older type of intense short flame furnaces. A soft flame of sufficient spread to assure time for ignition will give the ignition without slagging the top of the bed. A slagging action on the top surface tends to make the bed impervious to the passage of air.

In this connection it may be of interest to say that powdered coal works very well for sintering ignition. I know of only two plants now using powdered coal, the Evergreen mines in the Lake region, and Benson mines in upper New York. At this time it does not seem probable that powdered coal will ever be used where blast furnace or coke oven gas is available, because they are so much more convenient, but where such gas is not available the powdered coal works very well and I understand is less costly than fuel oil.

I would like to say a few words in general regarding the subject of beneficiated materials for blast furnace use and the effect which they have upon blast furnace practice. Probably there is no other subject of greater import before the iron and steel industry of this country than that of the future supply of raw materials for the blast furnaces. The members of this Association represent the trained engineering skill which must study this problem and select the best means for economically supplying those materials. May I urge you to study the problem with open minds. If there is one thought above all others which I would like to leave with you it is that regardless of the method of beneficiation used the character of the original material will be changed and that change will have its effect upon the thermal requirements of the blast furnace operation using the beneficiated material when the percentage of the new material becomes large enough in the furnace burden to make its presence felt. I believe the acceptance of this simple fact is the key needed for opening the door to a better understanding of the problem of ore beneficiation and a clarification of the subject into its proper divisions of production and use, each of which is a separate operation and governed by different principles.

For many years in the soft ore furnace operations it has been general practice to sinter flue dust, or a mixture of flue dust and ore, but the percentage of sinter used in the furnace burdens has been relatively small. This small percentage of sinter served to open the soft ore stock column to a better passage of gas and probably in some operations permitted harder blowing than when the small percentage of sinter was not in the mix. A natural reaction to this advantage was the desire for more sinter which would permit even harder blowing and consequently greater production. In some instances the additional sinter was provided but the anticipated benefits were not fully realized and the fault was blamed on the sinter.

Because of the varied results which have been obtained in different operations using sinter, apparently a belief has developed in some mysterious, elusive attri-

bute of sinter which is spoken of as sinter quality. In the field of literature there is a school of writers who are called debunkers because they dare to tell the truth about some hallowed beliefs. I will try to play the roll of a debunker in this hallowed belief in sinter quality. In my experience I have sintered and used in the blast furnace Lake hematites, North African hematites, a Greek hematite, New Jersey and New York magnetites, a sludge by-product of the aniline dye industry, and the pyrites residue from the sulphuric acid industry, and I will say without reservation that the only sinter quality to which I can attach any importance is the freedom from volatiles, the ability to absorb, conduct, and hold heat, and a small particle size which makes possible the efficient recovery of heat. The factors governing the successful production of such sinter lie in the chemical composition of the raw materials being sintered. The factors governing the successful use of such sinter in the blast furnace lie in the recognition of the thermal requirements of the blast furnace operation. The opinion is offered that the effect of the sintering operation upon the reducibility of the iron compounds in the sinter is of little practical importance in the furnace operation.

The ratio of the nonvolatile gangue elements to the iron in the sintering mix will not be changed by the sintering action, because the percentages of both increase in direct proportion to the percentage of volatile elements removed. Likewise, the effect of these nonvolatile gangue elements upon the chemical composition of the slag formed in the blast furnace will be the same whether they enter the furnace in the sinter or in natural materials. The effects of these gangue elements upon both the sinter and the furnace operation can be changed only by concentration or blending before the sintering action takes place.

The foregoing reasoning which has been applied to sinter would apply with equal force to nodulizing, briquetting, or any other method of beneficiation to the extent that the effects upon the furnace operation are in direct proportion to the degree of change in the original character of the raw materials which have been beneficiated.

Any of the large steel companies who wish to do it could prove the effects of fully beneficiated material upon the blast furnace operation by accumulating roll scale and using it in various percentages in the furnace burden. Roll scale is rich in iron, low in gangue and free from volatiles, and those are desirable properties in any form of beneficiated material. It has a large ratio of surface to mass, which is a desirable property of cellular sinter. It has density, which is claimed as an advantage for nodules. It has structural strength, a property of both sinter and nodules. Whatever silica is present exists as a silicate, the same as it does in sinter or nodules. In short, roll scale is a highly concentrated iron oxide material and has the same effect upon the thermal requirements of the blast furnace as any other highly concentrated iron oxide material which is free from volatiles.

Within recent months a questionnaire was circulated throughout the industry in which the question asked was: "What percentage of sinter was preferred for the blast furnace burden?" The answers varied from 0 to 100 per cent, which just about covers the range. Obviously they could not all be right. Again, obviously there must have been radical differences in the operating conditions to warrant such a diversity of opinions. The largest number of those who wanted some sinter asked for a fractional percentage of it; only two asked for 100 per cent. But numbers are sometimes misleading. The fact that the greater number preferred some fractional percentage of sinter rather than 100 per cent is not necessarily the whole truth about the value of sinter, even though in each case it was undoubtedly the truth with regard to the conditions under which the sinter was being used, but the two operations which had had a taste of 100 per cent sinter produced from high iron concentrates, and who use that sinter in the manner required for such materials by the thermal principals of the blast furnace, do not want anything else. It seems to me that the diversity of opinion among those who wished for some fractional percentage of sinter rather than 100 per cent of it is the best evidence that some important factor had been overlooked. Since they were all sintering Lake hematite ores or hematite dust, there could not have been any great difference between the sinters, and therefore it seems clear that the difference must have been between the characteristics of the major components of the furnace burdens, and because of these differences the critical percentage of sinter with regard to the thermal requirements of the respective furnace operations was reached with the diverse percentages asked for. I believe that for those who are studying the problem of ore beneficiation there is something in the answers of that questionnaire to think about.

**M. F. Morgan:** I think Mr. Duby is to be complimented on his paper, but I think he has been very modest in speaking of some of the design problems that involved his engineering department and the meager information that was presented to him concerning the design of sintering plants. I happen to be very well acquainted with the conditions under which he had to work. The preliminary problem that was presented to him was:

"We are going to build five sintering plants at different district plants and as they will all be the same you will design them at Warren."

An investigation was started as to what design plant would meet the requirements at the five different locations and we discovered that it would be necessary to design five sintering plants instead of designing one sintering plant. It has been pointed out before that sintering is not the same in any locality unless the same raw materials are used.

We also discovered that one plant that was to have a twelve windbox machine required a machine with sixteen windboxes to produce the required tonnage, because of the raw materials that were available for sintering; at another location we found a fourteen windbox machine was necessary to accomplish what was expected. All these changes — and the countless engineering problems encountered, solving the handling of the raw materials, etc. — were worked out at Warren. Each plant was a separate design, so it was necessary to make five separate designs instead of one design for five plants.

(*Please turn to page 61*)

# Continuous Determination

# OF OXYGEN AND COMBUSTIBLES

*. . . . rapid measurement of oxygen and combustible contents of gases offers great possibilities in the control of furnaces of all types . . . . equipment has been developed to do this efficiently and accurately . . . .*

**by J. F. LUHRS**

BAILEY METER COMPANY
CLEVELAND, OHIO

▲ THE excess air with which a furnace is operated always materially affects fuel economy, usually affects furnace maintenance, and in some cases affects product production and quality. It is the most important controllable variable in furnace operation. There is always one optimum excess air for any given furnace, fuel and set of operating conditions which will give maximum overall operating economy.

Usually this optimum excess air will be the minimum excess air at which the furnace can be operated with complete combustion of the fuel. Reducing the excess air below this point results in an unburned fuel loss, while increasing the excess air above this point results in an unnecessary heat loss to the stack. These losses are usually spoken of as "avoidable losses" as they are eliminated by operating at the optimum excess air.

An appreciation of the relative importance of the losses caused by incomplete combustion and by unnecessary excess air may be gained by a study of Figure 1. The curves in the upper part of the diagram are plotted from gas analyses and the lower curves show the losses due to excess air, products of combustion, unburned gases and latent heat.

The dotted curves indicate theoretical conditions, with the perfect mixing of fuel and air so that the quantity of total air for perfect combustion is denoted as 100 per cent. The reduction of air below this value would result in unburned gases which would constitute a loss approximately fifteen times greater for each per cent deficiency of air than the loss for each per cent of excess air. It will be noted that this curve is plotted in terms of percent total air, which is simply theoretical air for perfect combustion plus excess air.

In this particular furnace it was found that 30 per cent excess air was about the minimum which could be used without the presence of CO in the flue gases. This is shown by the solid flue gas analysis curve for CO which reaches zero at 130 per cent total air. It is also shown in terms of heat loss by the corresponding full line on the lower curve labeled "Unburned gas loss." The heat loss resulting from the use of excess air is also shown on the lower curve, and it will be noted that the excess air loss reaches approximately 2 per cent by the time the unburned gas loss reaches zero at 130 per cent total air. This excess air loss of approximately 2 per cent is, of course, less than the combined excess air loss and CO loss which would result from operation at any point below 130 per cent total air. This fact is shown graphically by the curve marked "Total flue gas loss in CO and latent heat."

While Figure 1 relates specifically to a coal-fired boiler furnace, the fundamental principles involved are applicable to an open hearth or any other type of metallurgical furnace and the relative magnitude of the

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losses will be the same. Obviously the excess air which will give maximum fuel economy varies, depending upon the type of furnace, type of fuel and type of fuel burning equipment. In a properly controlled cement kiln, for example, where fuel and air are well mixed by turbulent flow through the entire length of the kiln at temperatures well above the ignition point, it is possible to come very close to perfect combustion. Kilns under these conditions have been operated at complete combustion with as low as 1 per cent excess air. Well designed and controlled industrial furnaces usually require at least 5 per cent excess air, while modern water-cooled boiler furnaces usually require at least 10 to 25 per cent excess air, the variation depending upon the method of firing.

In special cases there may be certain operating conditions which will be the dominant factor in determining the optimum excess air rather than those so far considered. In the case of metallurgical furnaces this might be the necessity for maintaining a reducing or oxidizing atmosphere, or a particular type of flame. In the case of boilers it might be the maintenance of a predetermined steam temperature, control of slag formation, or furnace maintenance. The fact remains, however, that regardless of the determining factor there is one excess air which gives maximum economy and any departure therefrom represents an avoidable combustion loss.

## EFFECT OF EXCESS AIR ON FURNACE TEMPERATURE

Excess air in addition to having a vital effect on

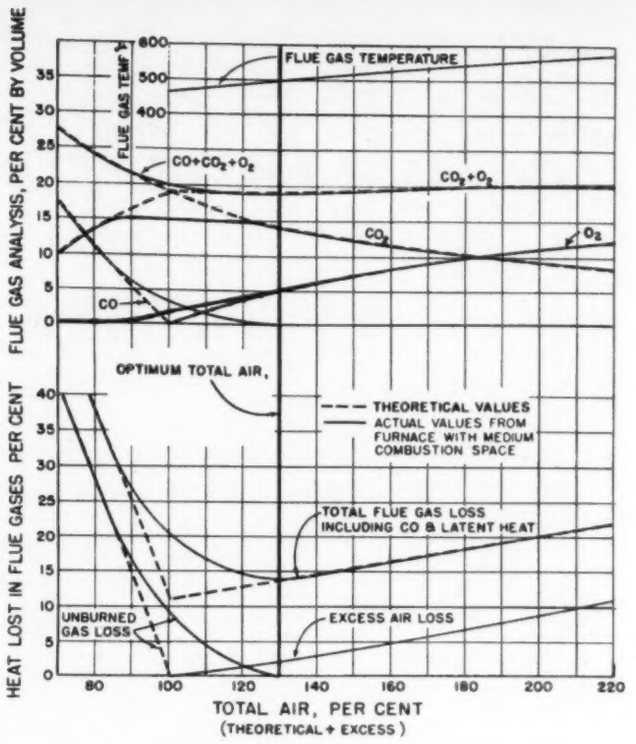



**Figure 1 — Combustion diagram showing relation between unburned fuel loss and excess air loss.**

▲

**Figure 2 — Comparison of $O_2$ and $CO_2$ in flue gas as indicators of excess air with various fuels.**

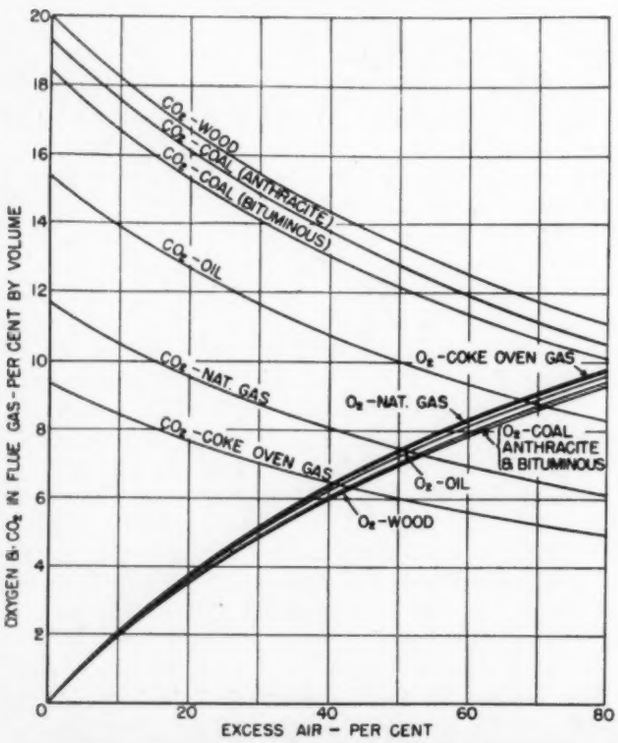
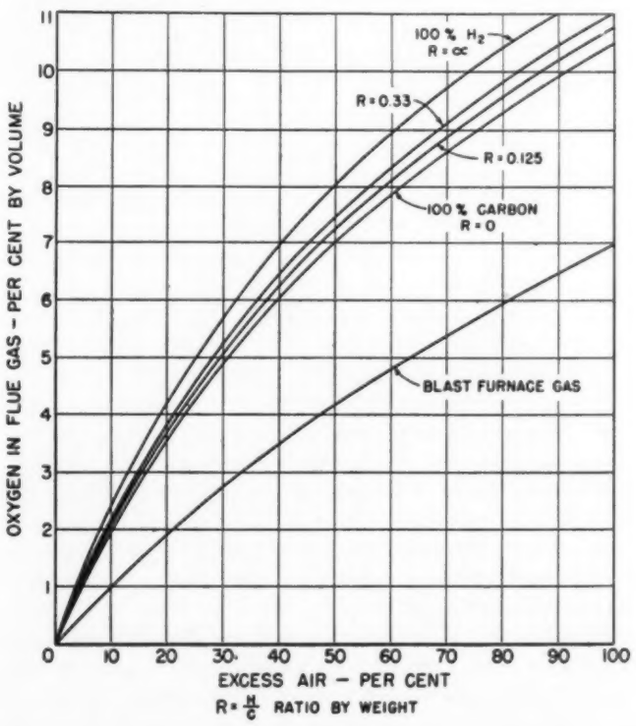



**Figure 3 — Relationship between excess air and $O_2$ as a function of H/C ratio of the fuel. Following assumptions may be made with no significant error:**

| | |
|---|---|
| **Coal and coke** | **R=0** |
| **Fuel oil** | **R=0.125** |
| **Refinery gas** | **R=0.24** |
| **Natural gas** | **R=0.33** |


100 % H₂ R = ∞
R = 0.33
R = 0.125
100 % CARBON R = 0
BLAST FURNACE GAS
OXYGEN IN FLUE GAS - PER CENT BY VOLUME
EXCESS AIR - PER CENT
R = H/C RATIO BY WEIGHT

combustion economy also has an important effect on furnace temperature. There is, theoretically, approximately a 200 degree decrease in temperature developed by combustion for each 10 per cent increase in excess air. Since radiant heat transfer is a function of the fourth power of the absolute temperature differences, the effect of unnecessary excess air in the operation of an open hearth, for example, where the heat transfer is almost entirely by radiation, can well be appreciated. This also explains why it is the natural tendency of the operator to regulate heat transfer by means of the air supply with no consideration of the effect of excess air upon the efficiency of combustion.

The determination of excess air, because of its relationship to fuel economy, furnace maintenance and temperature, has always been of importance to the designers and those responsible for the operation of furnaces and fuel burning equipment. The first group is interested because it gives them a check on how closely they were able to have actual optimum excess air approach the condition of perfect combustion. The second group is interested because it gives them a guide for actually operating equipment at the established optimum, and also because it gives them a check on the physical condition of the furnace and fuel burning equipment.

## FLUE GAS ANALYSES

One of the oldest and best known methods of determining excess air is by quantitative analysis of the flue gas. Probably because it is the easiest constituent to measure, $CO_2$ has frequently been taken as a measure of excess air. In a single fuel of uniform composition there is a definite relationship between $CO_2$ and excess air. However, as shown in Figure 2 the excess air for different fuels varies tremendously with the same $CO_2$ content. Thus under the condition of perfect combustion the $CO_2$ varies from approximately 11.7 per cent for natural gas to 15.4 per cent for oil to approximately 18.6 per cent for bituminous coal. It varies more than 1 per cent with different kinds of coal. In some cases $CO_2$ is given off from the material in the furnace, as for example in cement kilns and open hearths, which causes a further inaccuracy in the assumption of a predetermined relationship between excess air and $CO_2$.

$CO_2$ content of the flue gas, if used alone as an indication of excess air, may give a false reading because the same $CO_2$ corresponding to a given excess air may be obtained when a deficiency of air is present. For example, assume that on a gas fired furnace 7 per cent excess air was established as the optimum, which corresponds to 11 per cent $CO_2$. This same $CO_2$ may be obtained when there is a deficiency of air present, as the $CO_2$ content rises to a peak at zero excess air and decreases from that point with an increasing or decreasing air.

A fact which Figure 2 also brings out, and a fact which probably has been appreciated more by the steel industry than any other industry, is the substantially constant relationship between the oxygen content in the flue gas and excess air. As it is usually the oxygen contents below 7 per cent which are of interest, it is evident that the variation between fuels is negligible. In Figure 3 oxygen has been plotted against excess air in such a way as to bring out the fact that such variations in the relationship between oxygen and excess air as exist are a function of the hydrogen-carbon ratio of the fuel. If a high degree of precision is desired Figure 3 may be used to determine the exact excess air corresponding to a given oxygen content when the hydrogen-carbon ratio of the fuel is known.

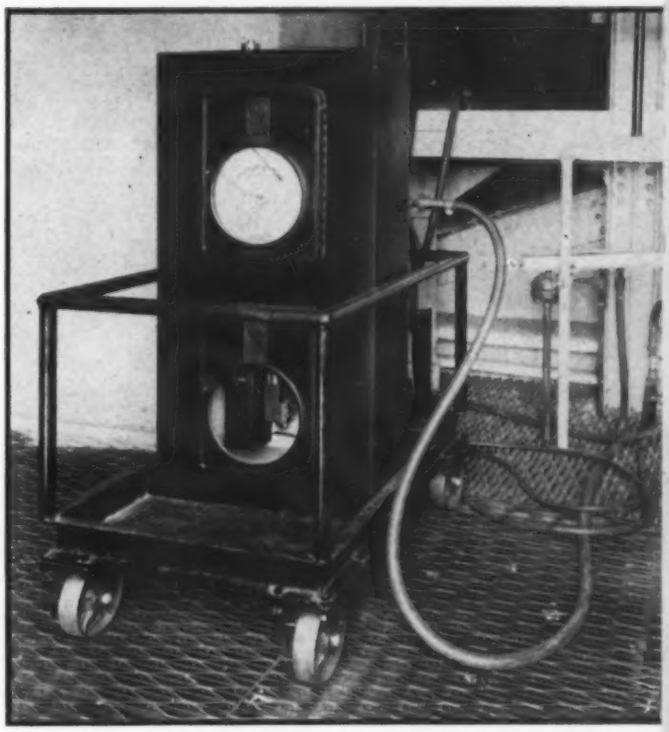


**Figure 4 — Oxygen recorder mounted on mobile carriage for test work in large central station.**

Figure 3 also illustrates the fact that with a fuel containing a large percentage of inerts, of which blast furnace gas is probably the only commercial example, there is a greater diversion in the oxygen-excess air relationship than for the usual hydrocarbon fuels.

It is possible, as shown by Figure 1, to have both oxygen and combustibles present simultaneously in the flue gas, and for this reason it is always advisable to check for combustibles in determining the optimum excess air. As the oxygen content does not increase as the air goes from an excess to a deficiency however, the condition of having the same oxygen content for a deficiency and an excess air which was explained with reference to $CO_2$ will never occur. In the case of fuels having a high hydrogen-carbon ratio, such as natural gas, it is possible that the combustibles will not appear as CO but as aldehydes or hydrocarbons ("New Combustion — Control Methods for all Standard Fuels," by Robert Reed, A. S. M. E. Transactions Vol. 66, No. 5. "Flue Gas Computations," by A. A. Bato, Mechanical Engineering, Vol. 48, 1926).

The orsat has long been used to analyze flue gases for $CO_2$, $O_2$ and CO to determine excess air. Such analyses afford at best but momentary glimpses of combustion at isolated intervals of time. They do not provide a

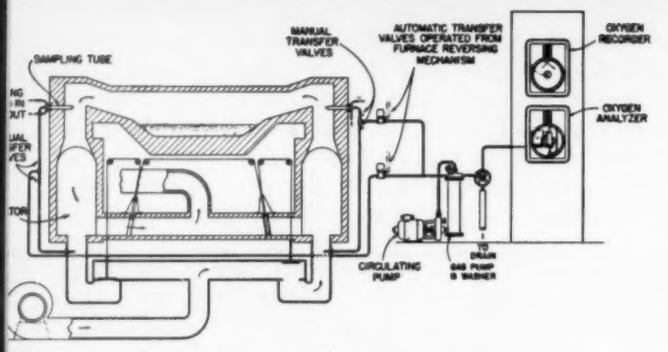



**Figure 5 — Schematic installation of oxygen recorder on open hearth arranged to take continuous sample from downtakes or regenerator outlets.**

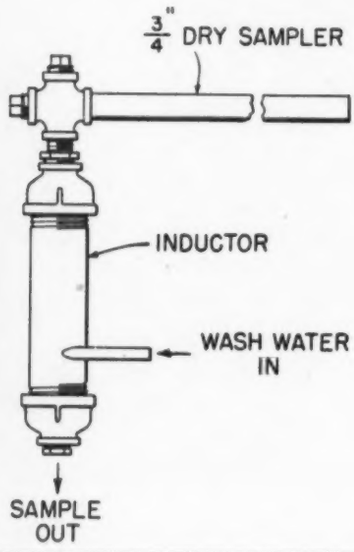



**Figure 6 — Sampler for continuous service in dusty gases.**

satisfactory operating guide because of the continuous labor involved in making the analyses, and because they give the operator history rather than news. Information as to what furnace conditions were five minutes ago is not particularly helpful in making adjustments to meet present conditions. Even as a test instrument the orsat leaves much to be desired. Because of the time involved in completing analyses, during which combustion conditions may change, the correlation of such analyses with other data becomes extremely difficult, if not impossible.

## CONTINUOUS OXYGEN OR EXCESS AIR RECORDER

In view of the substantially constant relationship between excess air and oxygen content of the flue gas, regardless of the fuel or combination of fuels, it is evident that a continuous and automatic oxygen recorder is an excellent combustion guide and of use not only to operators but to designers of fuel burning equipment and test engineers as well. During the past few years considerable work has been done toward the development of such a recorder and material progress made in adapting it to the conditions found in steel mills and other industrial plants.

Figure 4 illustrates a continuous oxygen recorder arranged for portable use and a schematic illustration of a permanent installation on an open hearth is shown in Figure 5. The recorder proper consists of two units. The analyzer, which in the arrangement shown, occupies the lower case, with the electronic recorder unit occupying the upper case. The analyzer unit mixes a continuously flowing sample of flue gas with the vapor from a standardized liquid fuel. Combustion of this mixture on a metallic filament burns the oxygen from the sample. Heat developed by this combustion changes the electrical resistance of the filament, which in turn is measured by the electronic type motor-driven recorder unit. As only electrical connections are required between the analyzer unit and recorder, they may be located remote from each other. A very short sample transportation lag is obtained by delivering to the analyzer a sample of from one to two cubic feet per minute. In the usual industrial installation the maximum time lag between a change in flue gas composition and the recording of that change will be in the order of ten seconds.

## CONTINUOUS COMBUSTIBLES RECORDER

In certain cases where low excess air or reducing atmospheres are encountered, a recorder of the combustible content in flue gas is also of value. As has been suggested, it is possible to have free oxygen and combustibles simultaneously present in flue gas, and these combustibles may not be CO. Along with the oxygen recorder there has therefore been developed a combustibles recorder which gives a reading proportional to the total combustibles in the flue gas. The same principle is used as in the oxygen recorder. In this case a continuously flowing sample of the flue gas is mixed with a predetermined amount of air and passed around a metallic filament without the addition of a fuel.

Usually it is desirable to have the combustibles unit record on the same chart as the oxygen recorder, and the two units may be housed in the same cases. There are certain instances, however, where the combustibles unit may be of value alone. For example, it may be used to check the operation and adjustment of a prepared atmosphere gas generator where a reducing atmosphere of predetermined amount is desired.

## THE SAMPLING SYSTEM

The continuous sampling of a dirty or slag-carrying flue gas, with freedom from plugging of the sampler or sample line, has presented an interesting problem. Flue gas contains water vapor and when the temperature of the sample is reduced to the dew point the condensed water vapor causes the dirt to become sticky. The usual sampling system soon plugs at this point. At locations where molten slag is carried in suspension by the flue gas the opening into an ordinary water cooled sampler is soon sealed shut.

For use in locations where water cooling is unnecessary a dry sampler, as shown in Figure 6, has been developed. As soon as the sample leaves the flue and

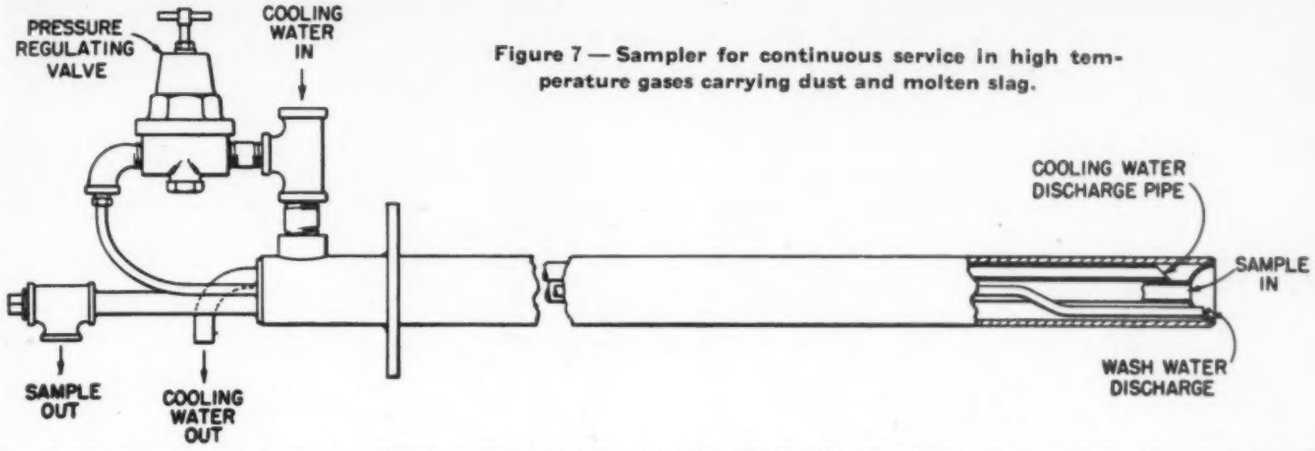



**Figure 7 — Sampler for continuous service in high temperature gases carrying dust and molten slag.**

before its temperature is reduced to the dew point, it is "quenched" by a small amount of wash water continuously introduced into the inductor in such a way that no back splashing occurs. Samplers of this type have run indefinitely on gases carrying upwards of twenty grains per cubic foot of solids.

If a water cooled sampler is required the flue gas is reduced below the dew point in the sampler with consequent plugging. Also, at high temperatures molten slag is frequently present, which solidifies on the surface of the sampler and soon closes over the opening. To meet these conditions a water cooled, water washed sampler has been developed, as shown in Fig. 7. In this sampler a small amount of wash water is discharged across the cup shaped opening so that the gases pass through a curtain of water before entering. Part of the wash water is carried back with the sample, and part discharged into the gas passage. A pressure regulating valve is provided, so that the rate of wash water flow may be regulated.

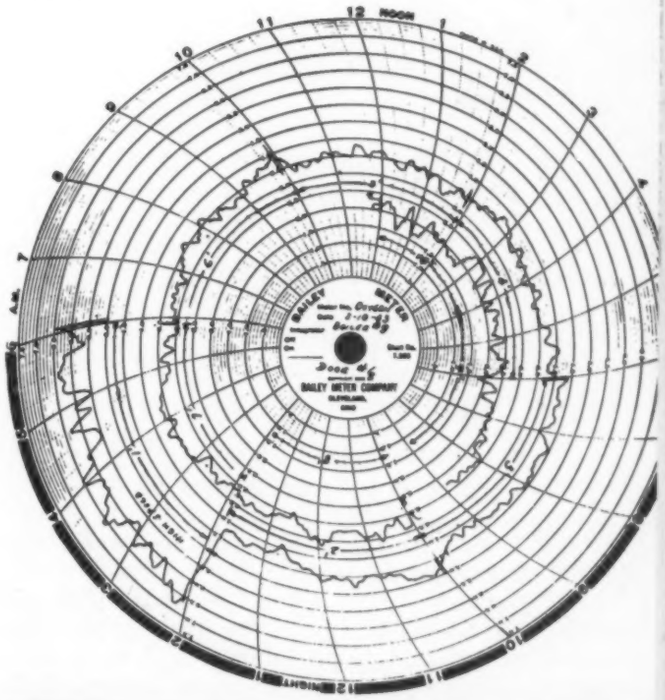
It will be noted that with both types of samplers wash water is carried back with the gas sample. This water serves to keep the sample line open, and also to remove a large proportion of the solids from the flowing sample.

Referring to Figure 5, the sample along with the wash water is drawn from the sample point by means of the washer pump unit. This unit also thoroughly washes the sample. Washing has been found to be a more satisfactory method of removing solids than filtering. The washer unit is, in effect, a highly efficient self-cleaning filter. The wash water is removed from the system by means of the separator, a clean moisture-free sample being delivered to the analyzer.

## SAMPLER LOCATION

Of great importance is the proper location of the sampler so that the information obtained will be representative of actual conditions. If the recorder is to be used as a combustion guide, generally speaking, the sampler should be located at a point where combustion is complete, but ahead of any appreciable air infiltration. On large furnaces having several burners it may be desirable to locate a sampler adjacent to each burner and successively transfer the recorder to each sampler. Fuel and air may then be adjusted to each burner to maintain uniform combustion conditions across the furnace. Tests which have been made indicate that while an analysis of a so-called representative flue gas sample may indicate good combustion conditions, combustion across a large furnace may be actually very ununiform, resulting in lower furnace efficiency. In some cases where the system is under pressure or the air infiltration is a constant and relatively small amount, the sampler may be located back a considerable distance from the furnace, and the readings obtained

**Figure 8 — High speed chart (1 revolution = 24 minutes) from $O_2$ recorder on pulverized coal fired boiler showing stratification and infiltration. Distance between sampler opening and side wall of furnace is shown on chart.**



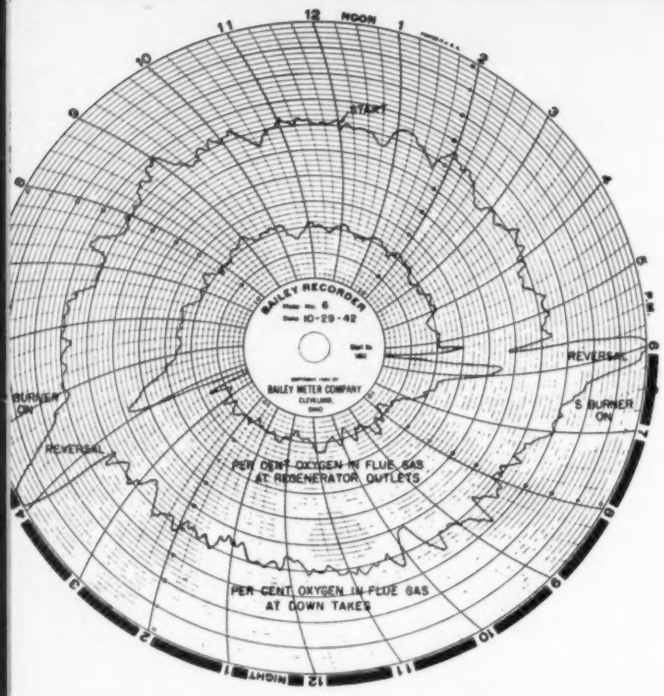
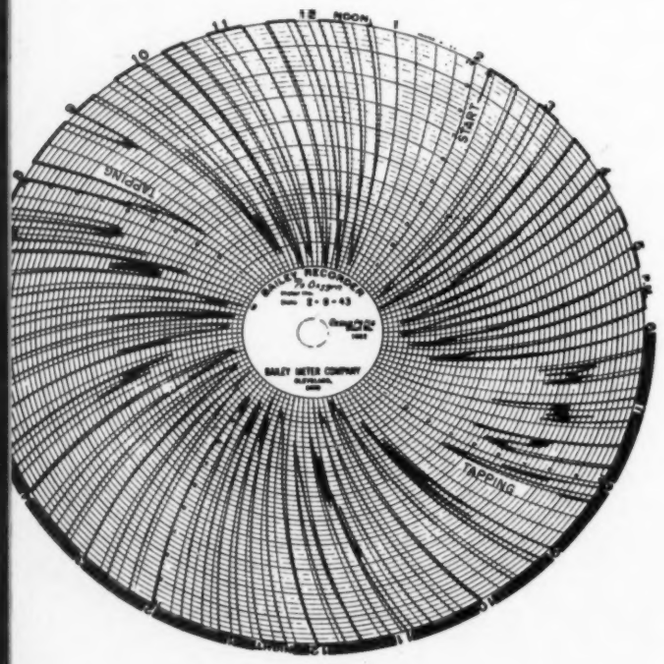



**Figure 9 — High speed chart (1 revolution = 24 minutes) from $O_2$ recorder on open hearth showing infiltration through regenerators. (Zero is at outside edge of chart.)**

**Figure 10 — 24 hour record of $O_2$ at the downtake of an open hearth. Recorder is alternately on air and flue gas.**




still relied upon as being indicative of actual combustion conditions.

The correct location of the sampler or samplers will vary with each type of furnace. The recorder itself may be used to make a study to determine the proper sampler location and may in the process bring to light valuable information. Figure 8, for example, is a chart

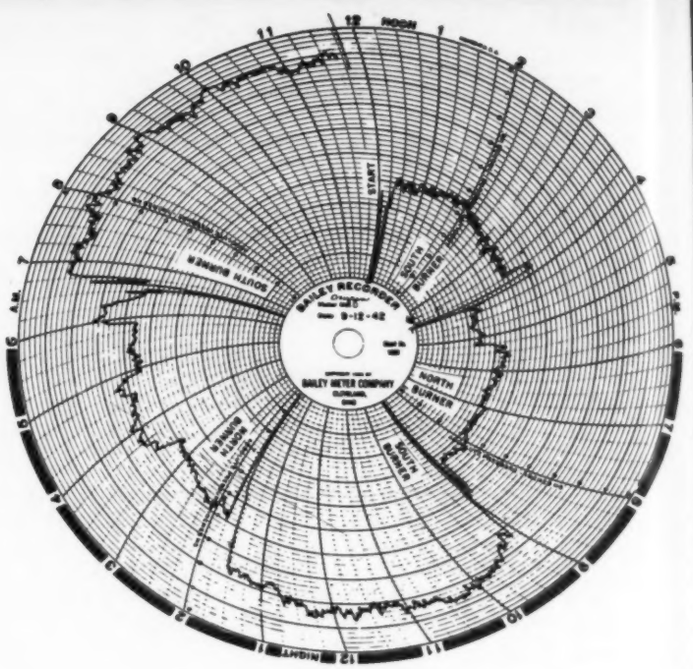



**Figure 11 — 96 minute record of the $O_2$ at the downtakes of an open hearth. Recorder provided with transfer valves for switching sampling point in synchronism with furnace reversals.**

from a large pulverized coal-fired boiler, made with a portable water-cooled sampler while running a traverse of the furnace. This is a so-called "high speed" chart, one complete revolution representing 24 minutes and each major time interval one minute. The dimensions given indicate the distance between the sampler opening and the wall of the furnace. Considering the fuel, the chart indicates fairly uniform fuel feed. As indicated by the oxygen content increasing as the furnace wall is approached, there is appreciable air infiltration.

Studies made on an open hearth indicate that if the recorder is to be used as a combustion guide the sampler should be located in the downtake as shown in Figure 5 rather than at the regenerator outlet. The chart shown in Figure 9 illustrates the air infiltration which may occur through a regenerator. It will be noted that the zero is at the outside of the chart and that this also is a high speed chart. As shown by the outer record, the oxygen at the downtakes averaged between 3 and 4 per cent, whereas that at the regenerator outlet as shown by the inner record averaged between 8 and 9 per cent. Of interest is the fact that the air leakage through one checker amounted to approximately 1 per cent more oxygen than through the other.

Figure 9, while showing that the oxygen content at the regenerator outlets cannot with safety be used as a combustion guide, also illustrates the value of the recorder as a means for checking air infiltration. To facilitate such use, as shown in Figure 5, manual transfer valves may be provided whereby a sample may be drawn selectively from the downtake or regenerator outlet, or a two-pen recorder may be used to obtain, as in Figure 9, simultaneous records of the oxygen at the downtakes and regenerator outlets.

Also as indicated in Figure 5, it is desirable to have a sampler at each downtake, as it is possible to have nonuniform fuel and air flows. Figure 10, for example, is a 24-hour chart taken from an open hearth having a sampler in a single downtake so that it is alternately on air and flue gas. The chart indicates relatively good management of the fuel-air ratio on one end by the melter. Obviously the chart would not indicate changes in the fuel-air ratio when firing from the other end, nor would it show differences in oxygen content between the two ends caused by different air leakage through the two checkers. On the other hand, Figure 11 is a 96-minute chart (zero at outside) taken from an open hearth with a sampler in each downtake and the recorder switched from one to the other in synchronism with furnace reversals. The record indicates a considerable variation in the oxygen content between the two ends. That some of this difference is due to unequal air supplies is illustrated by the fact that the rate of fuel feed between the time graduations 2-4 P. M. was equal, for example, to the rate of fuel feed between 2-3 A. M. In the former case the south burner, was being fired, whereas in the latter case the north burner was in action.

It is interesting to compare the character of the record on the high speed chart shown in Figure 11 with that on the standard speed chart shown in Figure 10, both made on the same service and under similar conditions. Where the recorder is to be used to analyze combustion conditions and to trace cause from effect it is evident that a more thorough and detailed study may be made from the Figure 11 record.

# DISCUSSION

PRESENTED BY


GENE S. KRATZER, Research Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

J. F. LUHRS, Application Engineer, Bailey Meter Company, Cleveland, Ohio

H. V. FLAGG, Combustion Engineer, American Rolling Mill Company, Middletown, Ohio

J. J. ALEXANDER, Assistant Superintendent Power, Republic Steel Corporation, Cleveland, Ohio

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

E. W. FITCH, Combustion Engineer, Republic Steel Corporation, Youngstown, Ohio

M. J. BRADLEY, Market Extension Division, Leeds & Northrup Company, Philadelphia, Pennsylvania


**Gene S. Kratzer:** In connection with that water-cooled sampler, as I understood it, there was a water spray across the entrance to the sampling tube. Wouldn't that have a tendency at high temperatures to affect the character of the gas itself by the water-gas reaction where you have a local high concentration of moisture?

**J. F. Luhrs:** We have never noticed any effect due to the water gas reaction. We have compared gas analyses obtained from a water cooled sampler and a water cooled, water washed sampler and have never been able to detect any difference.

**H. V. Flagg:** In the last twenty years we have known of several attempts to organize open hearth furnace operation on the basis of oxygen content in the flue gases, and I think we will all of us agree that the premise is sound and probably the best possible guide to combustion conditions. We have never had any particular difficulty in finding instrumentation to measure oxygen content satisfactorily, but collecting of the flue gas sample from a flowing stream of fume laden gases at extremely high temperatures has presented a problem which has never to our knowledge been adequately solved.

The ingenious expedient of using a water spray to cool and clean the sample as described by Mr. Luhrs is a step toward a solution of this problem. There is a question in my mind, however, whether the spray can be practical in a case like ours, where open hearth sampling tubes must be located in the end bulkhead and is exposed to temperatures as high as 2900 F.

**J. F. Luhrs:** We have used the water cooled, water washed sampler continuously in operating temperatures up to 3000 F, with no trouble due to plugging

The spray out of the end keeps the sampler clear of slag and also keeps the sample line open. Some of the water is spilled out into the flue. We have found that at high temperatures, this is not objectionable. It is carried along with the flue gases in the form of a fine spray until evaporated.

**J. J. Alexander:** Washing the sample by direct contact with water was described. To what extent is the analysis of the sample affected by the dissolved and entrained oxygen that might be liberated from the wash water?

**J. F. Luhrs:** The effect may be neglected in the flue gas analysis. One other question along that same line is how much oxygen from the flue gas is absorbed in the wash water? The answer to that is that the amount of wash water we are using is so small in proportion to the sample that absorption can be neglected. On the other hand the system cannot be used for $CO_2$ analysis, as $CO_2$ is quite soluble in water, and the $CO_2$ content in the gas sample after washing may be, for example, 1 per cent less than in the gas sample before washing.

**E. C. McDonald:** The discussion seems to be centering around the removal of dirt from sampling line, but I do not believe this detail seriously affects the applicability of an analyzer of this type.

Recently I have been doing some work on open hearth furnaces with a piece of equipment similar to the one described by Mr. Luhrs, and by taking the gas samples through a quartz tube and a glass wool filter, satisfactory results have been obtained. This instrument did not have a recorder but was equipped with oxygen and combustible indicators. When sampling gas in the downtake, we were able to very accurately

set the combustion of our open hearth furnaces. By means of a second instrument sampling from the flues after regenerators air infiltration can very quickly be detected.

It is very essential when working with this type of instrument to be alert to error in the determinations. For this purpose, the portable orsat should be available, with an occasional check with laboratory apparatus. I believe the future of instruments of this type is assured, but to show their justification it is essential that they be made portable so as to be able to spread the investment over many applications.

**J. J. Alexander:** You use the vapor from a standardized fuel. How frequently does that have to be added to the instrument?

**J. F. Luhrs:** In the particular instrument described, a gallon of fuel lasts approximately a month when the recorder is in continuous service. There is no mechanism involved in having the fuel vaporized other than having it flow onto a stone wick at a constant rate — a very small rate of flow, of course.

**E. W. Fitch:** Determination of oxygen and combustibles simultaneously in flue gases is certainly the basic and most correct means of determining combustion efficiency in any type of furnace. I believe that an instrument of this type, if it is rapid and accurate as described, certainly has a wide application in the industry.

I would like to ask Mr. Luhrs if this instrument is adaptable to automatic control of fuel-air ratio. It seems to me that it might have quite an application there, particularly on mixed fuels and certain types of furnaces where it is difficult to measure the fuel-air ratio in any other way.

**J. F. Luhrs:** This recorder has not been applied to the automatic control of fuel-air ratio on an open hearth as yet. We have applied it to automatic combustion control on boiler furnaces, glass tanks and on several catalytic processes that are used in the oil industry.

So far it has served as a combustion guide or as a tool for studying combustion conditions rather than as an element of an automatic control system. When tying it into automatic combustion control, it is used as a readjusting device. That is, the fuel and air are simultaneously varied either manually or automatically when a change in heat release is required and the oxygen recorder controller then readjusts the rate of air flow, or in some cases the rate of fuel flow, to maintain a predetermined constant percent of oxygen (excess air) in the flue gas.

Fundamentally it is probably more correct to readjust the rate of fuel flow rather than the rate of air flow. Air is a substance which results in a surprisingly constant Btu value per pound. By that I mean that for each pound of air admitted to a furnace, a predetermined number of Btu will be released at a given excess air regardless of variations in the composition or Btu value of the fuel. Therefore, if a constant heat release is desired it can, for most commercial fuels, be obtained by maintaining a constant excess air (constant percent oxygen) by varying the rate of fuel flow.

**M. J. Bradley:** The determination of the constituents in flue gases has followed a pattern quite similar to that developed in temperature determinations. First, the intermittent determinations which may or may not have given a true picture; second, intermittent but much more frequent analysis with the results shown on an indicator; third, the present stage, continuous analysis and continuous recording. If one carries the analogy still further, we may expect the continuous recording to lead to continuous automatic control of the air-fuel ratio or at least to its use as a vernier correction on metered air-fuel ratio which does not measure the air infiltration into the furnace system.

Each step in the development has been the result of a demand from industry for equipment which will enable them to obtain the desired information. The value of the information as an operating guide has increased the demand for more complete analysis and a continuous record. At present, results are being obtained which were considered practically impossible a few years ago and operating methods and equipments are improving quite rapidly under the stress of necessity.

Mr. Luhrs has presented quite convincing arguments indicating the value and necessity for continuous gas analysis as a combustion guide, especially on industrial operations where chemical reactions liberate additional gases which mix with the combustion products, such as takes place in an open hearth furnace or in a lime or cement kiln. Other examples could be mentioned, however, those listed serve the purpose adequately.

We agree that on many furnaces certain operating conditions will be the dominant factor in determining the optimum excess air rather than the consideration of complete combustion. Complete combustion is not necessarily the most efficient combustion conditions on all furnaces. For example, Figure 1, showing conditions for a coal-fired boiler furnace, indicates the efficiency in using 30 per cent excess air to obtain complete combustion. Also, if the excess air is reduced to 10 per cent, it would result in a 5 per cent increase in heat loss due to the unburned gas escaping in the waste gases at a temperature below 500 F. However, in the case of the open hearth furnace, the same amount of decrease in the excess air should increase the flame temperature roughly 400 F, which is desirable, and in addition the small volume of unburned gas, chiefly CO, would be burned before reaching the checkers and the bulk of the heat loss regained and returned with the preheated air used in combustion.

The method of continuous analysis outlined appears reasonably simple and direct. Basically, it functions on principles which have been under investigation as far back as 1920. Some of the following points have been mentioned in the previous discussion, however, it would be well worth while to have more information on them.

1. How long does the metallic filament stand up when operating under industrial conditions?
2. Does it become poisoned by metal fumes, carried along in the waste gases?
3. Does it change in electrical characteristics, or does its accuracy remain constant throughout its operating life?
4. How close must the ratio of liquid fuel to gas sample being analyzed be maintained to prevent errors in the analysis?

The answers to these questions should give some idea of the maintenance connected with the analyzing unit.

The method of collecting and cleaning the gas sample

for analysis is the most difficult and troublesome part of continuous gas analysis. A great deal of work has been done on this phase of the problem and various methods have been tried out in order to develop a procedure which will remove the dust, smoke, and metal fumes, etc. from the sample and at the same time require a minimum of maintenance. On small intermittent samples the difficulties are not excessive. However, on a continuous 24-hour sample day after day collecting volumes many times that required for analysis in order to cut down the time lag in sampling, the difficulties become of major importance. The solution of these difficulties often means the difference between a successful installation and one that is given up as hopeless.

The method of introducing water into the sampling line at or near the inlet with the gas sample is a new approach to the solution of these difficulties. It is evident that the continuous removal of the solids will materially lessen the possibility of the line plugging. However, the metal fumes which travel along with the gases do not generally wash out readily by this method. Also, the possibility of changing the percentage ratio of the various constituents in the gas sample either by their partial solution in the water or by the liberation of dissolved oxygen from the water entering the gas sample must be taken into consideration. This possible source of errors can be checked easily by collecting a dry sample at the same time and at the same location and making check analysis. No doubt this has been investigated.

On an open hearth furnace a long sampling line is required, possibly 100 to 150 ft in length, in order to place the analyzing unit across the charging floor near the other instruments as outlined in Figure 5. The size and length of the sampling line determines to some extent the sampling lag or the interval between the time when the gas sample enters the sampling line and the time it reaches the analyzing unit. This lag can be lessened by pulling a sample many times in volume that required for analysis. There is a limit in the size of the gas sample volume beyond which it is not practical to go because the cleaning difficulties also increase with the increase in volume. An approximate maximum time lag of 10 seconds indicates a very short sampling lag. We believe this refers to the start or indication of a change in the gas sample rather than to the actual final analysis. It is difficult to verify this rapid rate of response in studying the results recorded on the chart shown in Figure 10.

Another difficulty connected with the sampling problem is to determine the better location to use in collecting the gas sample. It is desirable to collect a gas sample which represents the actual conditions. However, due to stratification in the gas stream itself, it is very difficult to find a single location which remains representative in respect to waste gas composition and air infiltration. Figure 8 provides a good example of the results possible to obtain in the same gas steam at various locations. Figure 9 throws more light on this problem. The record shown for the downtakes certainly represents more nearly the actual combustion conditions. However, the record shown for regenerator outlets gives an overall picture including the air leakages into the slag pockets, the fantails, and the checkers. This furnishes a valuable guide for the repair and upkeep of the furnace. Certainly the condition of the complete furnace system plays an important part in the overall efficiency of open hearth production. Figure 9 gives a good idea of the sequence of the reversing operation. It appears to be well timed, possibly automatic reversing.

**J. F. Luhrs:** Mr. Bradley has called attention to some factors which must be given consideration in the selection of an instrument for a particular job. They are factors also which the manufacturer of the instrument must consider before recommending his instrument as being suitable for a particular service. They are in general factors which the user is not in a position to determine and he must, therefore, rely on the instrument manufacturer's recommendations.

Regarding the 10 second lag which I mentioned, it is correct that this is the time it takes from making a change in the fuel-air ratio until the effect is first felt on the recorder.

**J. J. Alexander:** I notice that the chart range on this recorder ran 0 to 10 per cent. Is there any method that will provide a check of the accuracy of the instrument, such as sampling the air and determining the per cent oxygen?

**J. F. Luhrs:** Yes. On this particular type of recorder there is an air check shunt which when opened throws an additional resistance into an arm of the bridge circuit and causes the pen to read on the chart with air passing through the analyzer.

A more complete check over the entire range of the recorder may be obtained by using gas mixtures having a known oxygen content. Such mixtures can be obtained in commercial cylinders from several manufacturers. One cylinder for example may contain a gas mixture having 1 per cent oxygen and 99 per cent nitrogen and another cylinder say 8 per cent oxygen and 92 per cent nitrogen.

We have found that with due precautions, that is, taking into consideration the high speed of the recorder, a reasonable check on the accuracy of the recorder can be made with an orsat.

**J. J. Alexander:** I believe you described the instrument in Figure 4 as portable. It looked rather sizeable to me. I am of the opinion that a combustible recorder might be of value in purging a gas line or gas vessel as a means of determining whether you did have the vessel purged and safe to enter.

**J. F. Luhrs:** Yes, it would be of value that way. We have not had any experience on that particular service, but there is no reason why it could not be used on that type of service.

You are quite right that the instrument was shown mounted on a mobile carriage and is not portable in the sense that it can be carried around by hand. We recognize the value of such an indicating instrument and, as a matter of fact, we have had mentioned here this afternoon one particular type of portable instrument.

There is certainly a definite field for a portable indicator to indicate oxygen and combustibles and if we may predict the future, I venture to say that some day an orsat is going to be quite obsolete because an automatic portable indicator will certainly have a tremendous advantage over the present scheme of pumping an orsat up and down in order to get a flue gas analysis.

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*by* **J. D. CAMPBELL,** STEEL MILL SECTION
INDUSTRY ENGINEERING DEPARTMENT
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SCHENECTADY, NEW YORK

▲ A few years ago the amplidyne generator was developed, and since then it has been advantageously used on many electrical applications and has created others where electric control methods were previously considered unsuitable or impractical.

The amplidyne has been clearly described in a previous article in the Iron and Steel Engineer ("The Amplidyne — A New Tool of Many Uses," by F. Mohler, A. I. S. E. Yearbook, 1940). The principles therein given are as true today as they were then, but the number and types of applications have increased beyond anything contemplated five years ago. Today the number of different applications are in the hundreds. The number of units now in use are in the thousands. Furthermore, detailed design changes in the unit itself has made it an ever more suitable and reliable machine.

In this article a brief review will be given of its history and how the amplidyne works. Its inner and outer appearance will be described. A few typical and fundamental circuits will be shown. In addition some of its industrial applications will be pointed out, with a description of what duties the machine is called upon to perform.

Presented before A. I. S. E. Detroit District Section Meeting, March 14, 1944.

The first and most fundamental forerunner of the amplidyne generator was a conventional shunt wound d-c generator. This machine has been with us for years, and we know that generally it consists of an armature with an armature winding and a commutator. Furthermore, it has a pair of load brushes riding on the commutator. It has a stator frame and a shunt field wound on its field poles. Finally, it is usually driven at constant speed by some driving motor.

Another forerunner of the amplidyne generator was the three-brush automobile battery charging generators. Until a few years ago, almost all automobile battery charging generators were of the three-brush type and were driven by the car engine. The three-brush generator had the characteristic of giving an almost constant battery charging current rate within a wide range of automobile engine speed. The setting of the current rate on the generator could be changed by shifting third brush position.

A third type of direct current generator was the Rosenberg railroad car lighting or battery charging generator. It had a pair of short circuited brushes and a pair of load brushes. It was driven by belting from the axle of a railroad car and gave a uniform current output for battery charging purposes.

The most recent predecessor of the amplidyne was the metadyne generator. It also was fitted with a pair of short circuited brushes and a pair of load brushes. The metadyne differed from the Rosenberg generator in that it was used in applications other than battery charging.

The amplidyne is a metadyne generator fitted with an additional field winding — a load current armature reaction compensating field.

## PRINCIPLES OF OPERATION

The amplidyne generator is an externally driven d-c generator outwardly similar to a conventional d-c motor or generator. Even though it is a dynamo-electric machine, it differs enough from the conventional d-c machine that it can stand alone on its unique characteristics along with the vacuum tube, the thyratron tube, the selsyn, the phototube, the copper oxide rectifier, the saturable core reactor, and the like. It owes its success to its inherently unique design utilizing a short circuit path between two brushes of a d-c machine, and to the use of a compensating winding on its stator. However, its success is also largely due to the ingenious use of control circuits to utilize the desirable characteristics of the machine. Although the general design has not fundamentally changed in the past five years, the variety of its external control circuits has increased many fold. In fact, the numbers of its applications are limited largely by the ability of the designer of its control circuits. In all cases it inwardly is essentially the same machine.

Figure 1 shows a schematic diagram of the principle components of the amplidyne. The figure is meant for illustrative purposes, rather than for accurately showing the details of construction. If a small direct current is sent through the control winding on the left hand pole, a control flux will be created on the horizontal or direct axis. The direct axis flux produces a voltage between the short circuit brushes, and short circuit current flows through the armature and back between the short circuit brushes. The ampere-turns produced by the short circuit armature current creates a flux in the vertical or quadrature axis. Voltage will then appear at the load brushes, and current will flow from the load brushes to the external load.

The load current in the armature will produce ampere-turns on the direct axis tending to oppose the ampere-turns of the control winding. This unwanted condition is prevented by means of a load compensating winding on the direct axis, as shown on the right hand pole of Figure 1.

The unit is thus a two-stage d-c amplifier, with the first stage from the control field to the quadrature axis and the second stage from the quadrature axis to the direct axis. Two major benefits result from such a two-stage amplifying machine. The first benefit is a high degree of amplification, and the second is a high speed of response to the control field signal.

Figure 2 shows only the essential fields of the amplidyne in schematic form. Other fields are used, but they need not be discussed here. Very often all the control fields shown are not provided, but in all cases an attempt is made to assign each control field number (such as F1 - F2) to a specific function. It should be noted that each control field is given a definite polarity; that is, a current flowing into any of the odd-numbered control field terminals will tend to produce a positive polarity at the C2 terminal. Likewise, current flowing into any of the even numbered terminals will tend to produce a positive polarity on the A1 terminal. Evidently the polarity of the load brushes may readily be reversed, and the control fields may be connected so as to aid or oppose each other. In all cases, the polarity at the load brushes will be determined by the

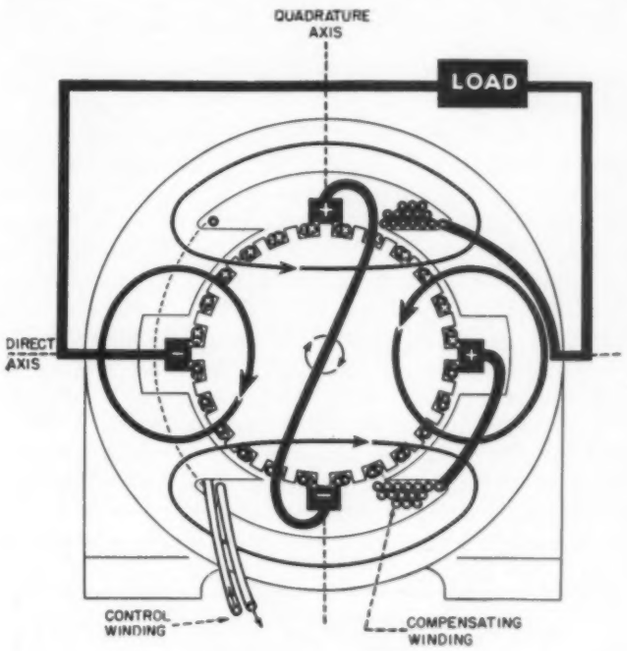


**Figure 1 — Principle components of the amplidyne.**

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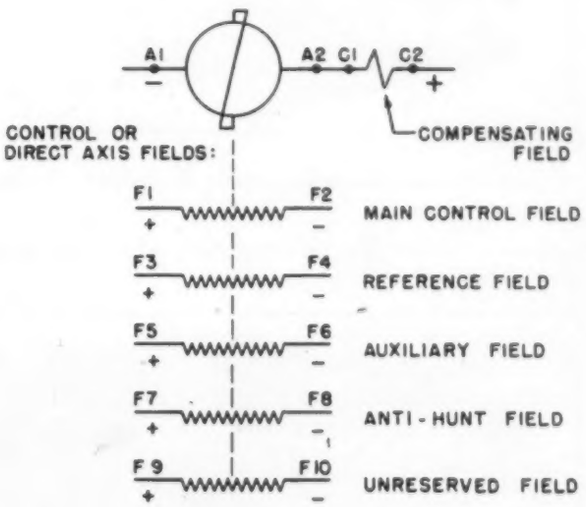
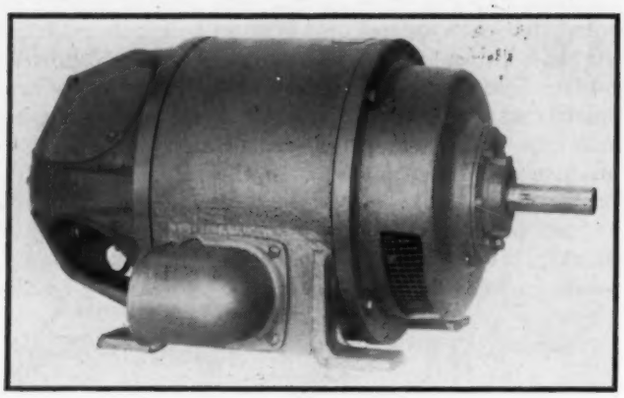
**Figure 2 — General schematic diagram for all amplidynes.**




NOTE: THE COMPENSATING AND MAIN CONTROL FIELD WINDING OF THE AMPLIDYNE HAVE THE SAME MAGNETIC AXIS AS THE LOAD CURRENT IN THE ARMATURE.



algebraic sum of ampere-turns in all control field windings.

The large number and types of windings may at first appear confusing. This need not be the case when we consider the following. A d-c shunt wound generator also may have many windings. It could have several shunt field windings, a series field, a compensating or pole face winding, an armature winding, a commutating field, armature equalizer connections, or the like. Yet when we apply such a machine to a particular job, we generally consider the fact that if we apply voltage to any one set of shunt field terminals we get voltage at the armature terminals. If we reverse the shunt field polarity, we will reverse the armature terminal polarity. The situation is almost the same with the amplidyne, which may have an equally large number of fields or windings. Yet, here again, if we apply voltage to

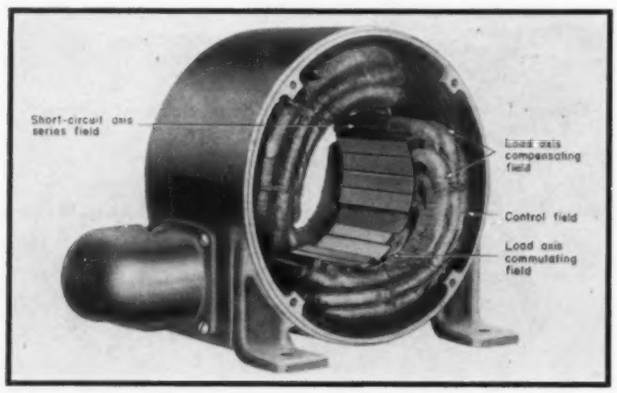



**Figure 5 — Stator frame and stator winding of amplidyne.**

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**Figure 6 — Amplidyne motor-generator set for smaller ratings.**

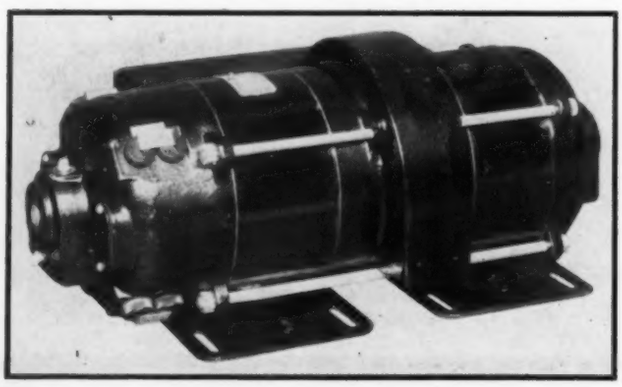
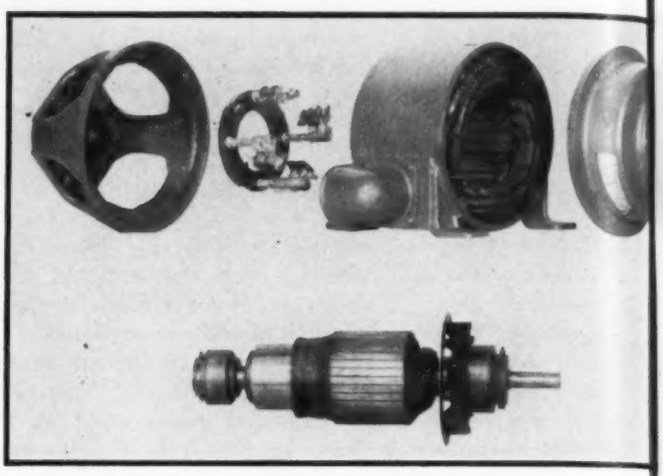


**Figure 3 — Complete amplidyne generator without driving motor.** ←

**Figure 4 — Disassembled view of an amplidyne.** ↓



any one control field, a voltage will appear at the load brushes. If we reverse the polarity of the control field, we reverse the load brush polarity. We find it thus unnecessary to consider all the intermediate steps in going from the control winding to the load brushes.

## RATINGS

In output ratings of 3 to 25 kilowatts, inclusive, amplidyne generators have been built as shown in Figure 3, where the driving motor is not shown. Figures 4 and 5 give views of the internal construction of the same unit. These photographs illustrate how closely the construction compares with a conventional d-c generator. It might also be noticed in Figure 5 that the compensating winding is distributed around the stator, somewhat like the stator winding of a squirrel cage induction motor. Distributed windings such as these have been found superior to the block compensated windings illustrated in Figure 1.

In ratings of 200 to 1500 watts, amplidyne generators have the general construction illustrated in Figure 6. Here the driving motor and the generator are integrally mounted, and have a two-bearing construction for the complete set.

Nameplates have been made sufficiently comprehensive for the man in the field who installs or maintains such equipment. A typical rating for the unit of Figure 3 would be: 5 kw — 1750 rpm — 250 volts — 20 amperes — 40 C rise. The field winding data will differ for different types of applications.

In almost all applications we find the amplidyne used in one or several of the following functions:

1. As a generator, such as to furnish power to the armature terminals of a d-c motor.
2. As an exciter, such as to excite the shunt field of a motor or generator.
3. As an amplifier, such as to amplify a small voltage indication to some larger and more useable voltage value.
4. As a regulator, such as to regulate voltage on a

generator, or current in a generator, or speed of a motor.

5. As a tachometer generator, where low excitation power and high response speed is required.

Specific examples of places where the functions are combined is where the amplidyne:

a. Can control armature current of a d-c motor, and at the same time hold the speed and armature current of the motor within specified limits.
b. Can hold the power input to a motor constant by controlling both the armature voltage and armature current of a d-c motor.
c. Can be made to hold the torque of a motor constant or within predetermined limits.
d. Can control power input, power factor or armature voltage or combinations of several quantities on synchronous alternating current machines.
e. Can speed up operation of existing machines because of more uniform control of armature current and voltage during acceleration and deceleration of a motor.
f. Can limit such quantities as torque, current, voltage, excitation so as to protect other machines from damage.
g. Can function as an exciter, as an amplifier, as a generator, or as a regulator in conjunction with electronic devices.

## TYPICAL CIRCUITS

While the amplidyne has served in a great variety of functions, some of its most general applications have been to regulate some characteristic of an electric machine. Three common regulators are those concerned with voltage on a generator, armature current in a motor, and speed of a motor. The circuits shown in Figures 7, 8 and 9 are not the only ones which might be used, for different circuit arrangements have been used to meet specific applications. In addition, these circuits have been greatly simplified to the extent that no protective or limiting features are shown. Once the principles involved are understood, the addition of protective or limiting devices can readily be made.

Figure 7 shows a typical means for regulating the voltage on a d-c generator, where the amplidyne serves as a regulating exciter. Voltage on the generator is regulated by the combined actions of fields F1-F2 and F3-F4. Control field F1-F2 tends to lower the voltage on the amplidyne and thus tends to lower the voltage on the generator. Reference field F3-F4 tends to raise the voltage on the amplidyne. The regulated generator voltage will be at that point where the algebraic sum of the two field ampere-turns gives just sufficient excitation to produce the required voltage. Any change in load or speed of the generator will tend to change the generator voltage accordingly. Even a slight voltage change will alter the excitation on field F1-F2 in such a manner as to restore the generator voltage very closely to its former value. Evidently the value of regulated voltage can be readily changed by altering the value of either Res-1 or Res-2. The sensitivity of the regulator at any voltage can be changed by altering the values of Res-1 and Res-2. Generally speaking, the greater the ampere-turns in field F3-F4, the greater will be the regulator sensitivity.

A slightly different principle of operation is illustrated in Figure 8 where only one field controls the armature current of a motor. Here a reference voltage is used across potentiometer Res-2, instead of using a reference field, as shown in Figure 8. An armature current indication is obtained from the voltage appearing across armature Res-1. This voltage is compared with the reference voltage obtained from potentiometer Res-2. The difference between the two voltages excites control field F1-F2. If the load on the motor momentarily increases, the strength of field F1-F2 will be decreased, lowering the counter emf voltage on the amplidyne and hence increasing the motor field strength. The resulting increased motor torque will enable the armature current to be restored to its former value. A decreased load will have the opposite effect. Here again, the value of current at which we regulate can readily be changed by altering the tap setting on Res-2. In actual practice, small rheostats are used for making changes in the regulator setting.

The reference voltage scheme of control may also be applied to the motor speed regulator shown in Figure 9.

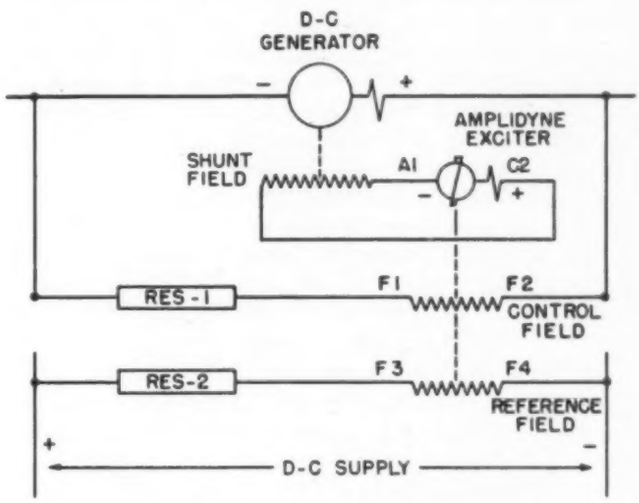



**Figure 7 — Generator voltage regulator.**

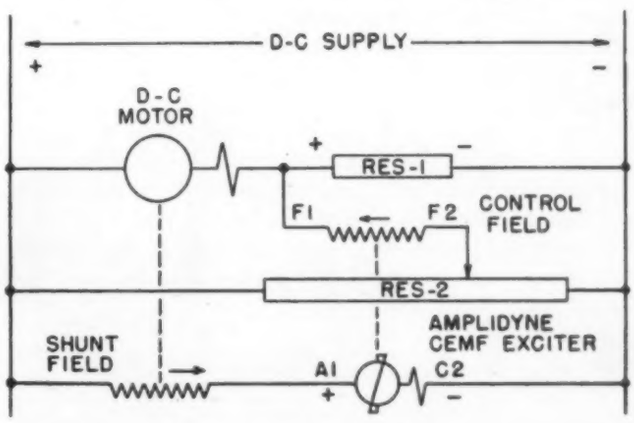



**Figure 8 — Motor armature current regulator.**

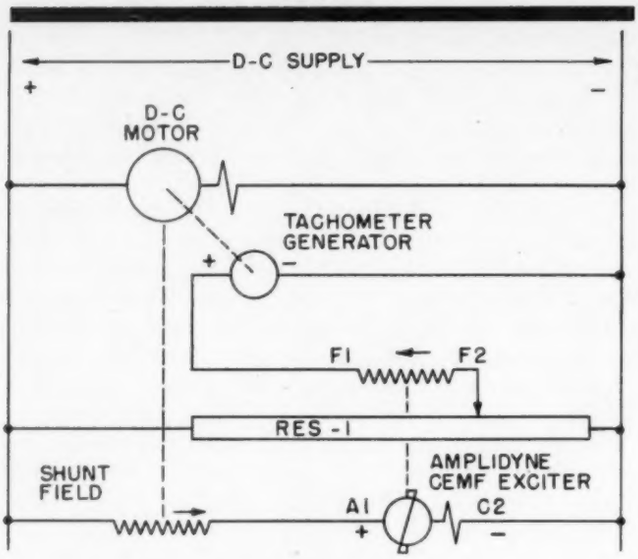



**Figure 9 — Motor speed regulator.**

A tachometer generator, driven by the motor gives us a voltage indication proportional to motor speed. This voltage is compared to the reference voltage across potentiometer Res-1. If the motor speed should decrease slightly, the strength of field F1-F2 will be increased, and the motor shunt field will be decreased in magnitude. The motor speed will thus be increased until the motor is brought very closely to its former operating speed. An increased motor speed will tend to increase the motor field strength, so as to lower the motor speed to its former value. Just as in the previous circuits, the speed setting may be changed by the tap on Res-1; or by a rheostat movement, where a rheostat replaces Res-1.

## APPLICATIONS

Amplidynes have been applied to aircraft devices, in the mining industry, in the steel industry, to machine tools, to electric power systems, to metallurgical methods, in the lumber industry, in the paper industry, and to a broad variety of special machines. In the steel industry they have been applied all the way from the iron ore operations up to operations on finished steel products. For example, they are in use on electric shovels used in open iron ore pits or in surface coal mines. They are used on blast furnace skip hoist control. Finally, at the finishing end, they are applied to hot and cold strip mills and to processing lines, such as the electrolytic tinplate units.

For typical examples in the steel industry we will examine the application in reversing hot mills, continuous hot strip mills, and continuous cold strip mills. All the applications illustrated in Figures 10, 11 and 12 are in actual use at present. These figures illustrate the wide range of actual uses in one phase of the steel industry.

## REVERSING HOT MILLS

In a reversing hot mill, such as sometimes precedes the continuous hot strip mill finishing stands, the amplidyne is used as indicated in Figure 10. This figure illustrates six distinct applications. The principal functions performed may be summarized in tabular form as follows:

A. *Liquid Slip Regulator*

a. It acts as a generator to furnish power to the slip regulator d-c torque motor.
b. It amplifies the load indication from the slip ring induction motor to limit its peak load through control of the slip regulator electrode position.
c. It simplifies automatic control of the regulator during starting of the flywheel motor-generator set or during dynamic braking of the slip ring induction motor.

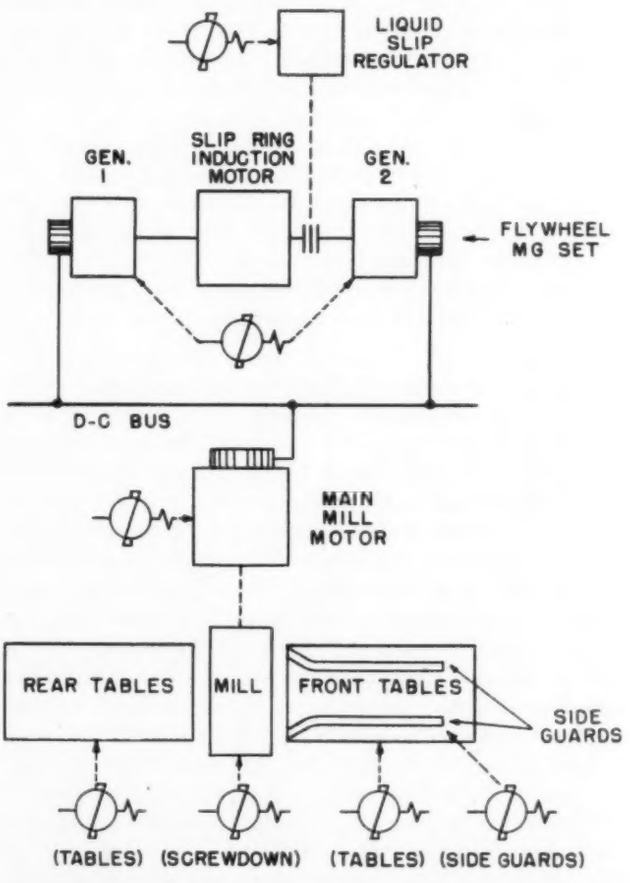
B. *Main Generator Control*

a. It excites the main exciter for the fields of main generators 1 and 2.
b. It regulates voltage on the generators, independent of load or speed changes on the flywheel motor-generator set.
c. It controls the direction and magnitude of the main generator voltage, as determined by the mill operator's master switch position.
d. It limits load on the generator to a predetermined value.

C. *Main Mill Motor Control*

a. An amplidyne here excites the field of the mill motor shunt field exciter.

**Figure 10 — Application of amplidynes to a reversing hot mill.**



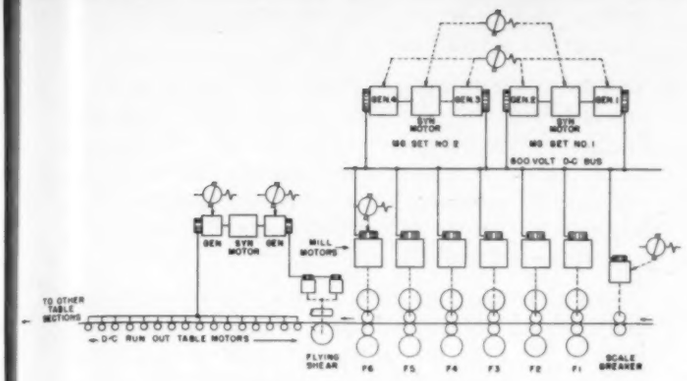



**Figure 11 — Application to finishing end of a continuous hot strip mill.**

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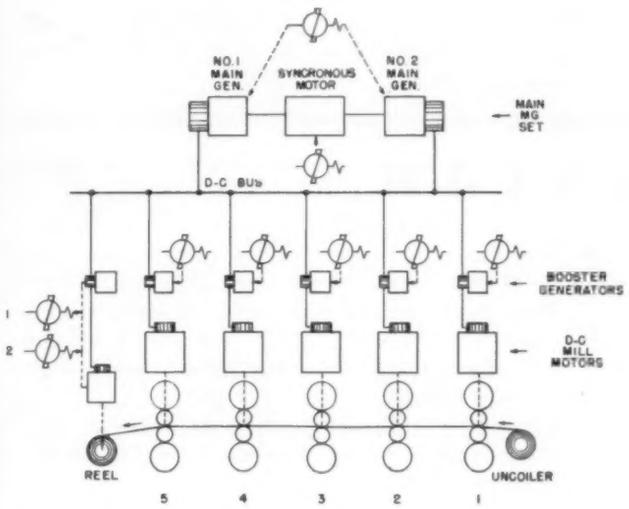
**Figure 12 — Amplidynes as applied to continuous cold strip mills.**




b. It controls speed of the mill motor, as determined by the operator's master switch position.
c. It limits the load on the mill motor, independent of the operator's master switch position.

D. *Table, Side Guard, and Screwdown Control*

a. Here an amplidyne excites the shunt field of the individual adjustable voltage generators. The generators in turn furnish power to the auxiliary motors driving the tables, side guards, and screws.
b. It regulates voltage on the adjustable voltage generator.
c. It controls direction and magnitude of the generator voltage.
d. It limits the load on the generator or the auxiliary motor.

## CONTINUOUS HOT STRIP MILLS

Figure 11 illustrates in schematic form the various places where amplidynes are used at the finishing stands and at the run out tables.

A. *Synchronous Motor Control*

a. An amplidyne excites the field of the synchronous motor exciter.
b. It regulates power factor (or reactive kva if desired) of the synchronous motors, to improve the voltage stability of the a-c power system.
c. It limits maximum and minimum excitation on the synchronous motors during starting or normal running periods.

B. *Main Generator Control*

a. It excites the field of the main generator exciter.
b. It regulates voltage on the generators; independent of load changes.
c. It controls the magnitude of the generator voltage, as desired by the finishing mill speed operators.

C. *Scale Breaker Control*

a. It serves as a counter emf exciter for the scale breaker motor shunt field.
b. It controls the field of the motor.
c. It limits load on the motor, within the limits of field control.

D. *Flying Shear Control*

a. Here two amplidynes are used. One serves as a tachometer generator on stand No. 6. The other excites the field of the flying shear main generator.
b. The exciter limits the load on the shear motors during acceleration, running, and deceleration of the shear.
c. It regulates the speed of the shear, with respect to stand No. 6 speed in conjunction with an electronic amplifier. In this sense, it functions as an "electric tie" between the shear and stand No. 6.
d. It controls the shear motor speeds for various length-of-cut settings desired by the shear operator.

E. *Run-out Table Motor Control*

a. An amplidyne excites the field of each runout table generator.
b. Its functions are similar to those of the amplidynes used on the reversing hot mill auxiliaries.

## CONTINUOUS COLD STRIP MILLS

A five stand tandem mill is illustrated in Figure 12. The main motor-generator set may be rated as high as 8000 kw, with the mill motors each rated 500 to 3000 hp, depending on the size of the mill. Amplidyne control of this type of mill has been instrumental in operation of one cold strip mill at a delivery speed of 4000 feet per minute.

A. *Synchronous Motor Control*

Here the unit functions the same as on the continuous hot strip mill, part A.

B. *Main Generator Control*

This unit has the same general functions, which differ only in detail, as the amplidyne on the continuous hot strip mill, part B.

C. *Booster Generator Control*

a. An amplidyne controls the shunt field of each IR booster generator.
b. It regulates the voltage on each booster generator so that the booster voltage is proportional to the mill motor armature current. In this way, the armature circuit IR drop may be compensated, and each mill motor will tend to maintain its speed

relationship with other mill motors, independent of load or bus voltage.

D. *Winding Reel Control*

a. Two amplidynes are used. One serves as an amplidyne exciter. The other serves as a counter emf regulating exciter in the winding reel motor shunt field circuit, and also regulates the booster voltage.

b. Together they regulate the reel motor armature current, so as to maintain uniform strip tension during acceleration, running, and deceleration of the mill.

c. They limit the minimum field excitation on the reel motor.

d. They control the running light speed of the reel during the threading operation.

## SUMMARY


Some principal reasons why the amplidyne has been so successful may be tabulated as follows:

1. It has a high degree of amplification, i. e., the ratio of output watts from its armature to the watts input to its control fields is high. Amplifications of 10,000 to 25,000 to one are possible.
2. It has high speed of response, i. e., its armature voltage and current will respond very quickly to a change in control field current.
3. The armature rotates at practically constant speed, but aside from this there is no mechanical high inertia or moving parts to hinder its performance as might be the case in the mechanical parts of a carbon pile regulator or a vibrator regulator. In a few words, there is no mechanical inertia and a very low electrical inertia.
4. Because the amplification is high, the input voltage or current to its control fields is small. Thus we can use small control contactors, small relays, small field resistors, or small dry type rectifiers for control purposes. The control devices are therefore small, simple and require little maintenance.
5. Since the amplification is high, and since the input to its control fields is small, the amplidyne has been applied in conjunction with electronic tube circuits, using vacuum tubes.
6. The unit itself is sturdy and trouble-free, requiring no more maintenance than a conventional d-c generator.


# DISCUSSION

PRESENTED BY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WALTER STERN, Electrical Engineer, United States Rubber Company, Detroit, Michigan

F. M. BAXANDALL, Engineering Department, The Dow Chemical Company, Midland, Michigan

O. J. MARSHICK, Fisher Body Corporation, Detroit, Michigan

H. E. PHELPS, Superintendent, Electric Furnace Department, Rotary Electric Steel Company, Detroit, Michigan

WILBUR A. STELZER, The Dow Chemical Company, Midland, Michigan


**L. R. Milburn:** In the amplidyne control, you bring out the feature that you deal with small currents. We find that in the steel mill at present this is sometimes a handicap, in that small particles of foreign matter — dust, graphite, and dirt — would affect the small contacts quicker than it would when using larger current values. Are you doing anything to overcome that?

**J. D. Campbell:** I believe that particular difficulty can be remedied by changing the location of these small current carrying relay contacts. The contacts may be in a six or eight volt circuit which is, say, part of a 250 volt circuit. It is usually possible to put the small contacts in the 250 volt circuit where the condition of low voltage and relatively high contact resistance does not exist.

**L. R. Milburn:** You might also have to change the type of contact in some instances, too, so the dirt cannot fall or lie on it when it is in an open condition.

**J. D. Campbell:** Yes, this situation of dirt on control devices may well exist in locations close to blast furnaces where dirt conditions are about as bad as anywhere in a steel mill.

**L. R. Milburn:** Do you think that an amplidyne would aid on a hot strip coiler to coil straight edges even on camber strip?

**J. D. Campbell:** In the crowded, wet conditions in a hot strip coiler, one problem is to locate a trouble-free device which would give us an indication of strip position. Secondly there is the mechanical problem of automatically moving the strip over to its desired position, as it is wound in the coiler. If these two problems can be solved, the amplidyne could no doubt be used successfully as the controlling device.

**Walter Stern:** With regard to the same application, that is, winding an even edge, you are using a motor which incorporates speed control, but in this case you actually reversed your rotation, didn't you?

**J. D. Campbell:** The control of a winder traverse motion is through what we call a position regulator. We get an indication from the edge of the strip which will increase the strength of the amplidyne control field; or if the indication shows the opposite condition, the same amplidyne field will be decreased in strength. Since a reference field opposes the control field, the amplidyne polarity may be thus readily

reversed. The traverse motor rotation can thus be reversed.

**F. M. Baxandall:** In the chemical industry, we have use for equipment of this nature, but it would have to be so as not to be affected by fumes, and some cases hazardous fumes. The d-c motor, of course, would be explosion proof, but is your control station designed so it can be made explosion proof?

**J. D. Campbell:** An explosion proof master switch can be used to control the amplidyne fields, just as explosion proof master switches can be used in other types of control.

**O. J. Marshick:** Would it be possible to use selsyn control to operate the rheostats in a master switch?

**J. D. Campbell:** Yes, but a selsyn has slip rings too, so that an explosion proof station might still be needed.

**H. E. Phelps:** In arc furnaces, do you find the saving in electrodes as the same percentage as the decrease in time and power? In other words, if the saving is one percent in time and power, will the electrode saving be one percent also?

**J. D. Campbell:** When comparing amplidyne arc furnace control with conventional control, there is some difficulty in making the comparison on the same basis. For example, many of the new arc furnaces had amplidyne control on them from the start, so we do not know for sure just what the same arc furnaces would do with conventional control. Also, many furnaces are used in a wide variety of melting down and refining conditions, where comparisons are further made difficult. Generally, though, we have data which shows that where amplidyne electrode control is used, there has been an electric energy saving of one per cent in melting down operations. The time of melting has been decreased by ten per cent, and there has been a slight saving in electrodes. The percentages may seem small, but the total savings over a year are appreciable.

**H. E. Phelps:** I have heard of some wonderful power savings, such as ten per cent. Your one per cent sounds more like it. Is it feasible to put amplidyne control on present arc furnaces that have contact regulators on them now?

**J. D. Campbell:** Yes, that has been done.

**H. E. Phelps:** Could you use the same hoist motors if you wished, or would it be necessary to change them?

**J. D. Campbell:** If the existing hoist motors are in good condition, there is usually no reason why they cannot be used. In some cases, the voltage rating of the existing motors may not be desirable for use with the amplidyne.

**Wilbur A. Stelzer:** In regard to the reference field on the amplidyne, do you require any special source for the d-c voltage?

**J. D. Campbell:** The reference field is the standard of comparison. When a close standard is required, it can be obtained in several ways. One common method is by using a voltage regulating transformer which has a secondary voltage that is, within limits, independent of primary voltage fluctuations. The secondary a-c voltage is rectified by dry-type rectifiers, so that a reasonably accurate d-c voltage becomes available. Very often, the voltage on a conventional d-c generator or exciter is constant enough for exciting the reference field.

## *Duby* DISCUSSION

(*Continued from page 44*)

I can truthfully say that many a sleepless night was spent on what should be done and how it should be done, and through the work of Mr. Duby and his engineering department, these plants were not only built, but they have accomplished what they were built for; and I think that in the design and in meeting the problems that were confronted, the job was done very well; the proof of the pudding is the economical operation of these plants.

A lot can be said about handling raw materials, and so on, but each plant is an individual problem with different raw materials to handle. The sintering machine, if the material is put on properly, will produce sinter, and I believe that sintering is 90 per cent handling the raw materials in the proper manner.

With regard to super-hoppers, each condition will govern what goes into a plant. The reason we have eliminated the super-hopper is that it causes segregation. Segregation is one of the major difficulties we have to combat in sintering. We know also that proper mixing is one of the most important factors in sintering. All of the details which I am bringing out here had to be worked out to handle the different materials for the five plants at one engineering department in Warren that had had no previous experience with the designing of sintering plants.

**G. M. Kyle:** I would like to ask Mr. Duby one or two questions of an operating nature. First, what is the most satisfactory vacuum on the suction fan to give best all around production and satisfactory sinter? Second, what is the best life that has been obtained on pug mill shafts and paddles? And third, has any hard surfacing of these pug mill shafts been tried to get greater life?

**C. J. Duby:** The fan was designed for 24 in. static pressure and it is pulling 18 in. suction at the inlet at the time we have an 11 in. bed on the sintering machine, using 55 per cent flue dust with a speed of 60 in. per minute. In answer to the second question we have had no trouble with paddles or pug mill shafts. They last about six months and are made of .80 carbon steel. We have not tried any hardening. We started operations in June of last year at Warren. In other words we have had about sixteen months' operation.


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# *Demulsifiers* IN CIRCULATING OIL SYSTEMS

*. . . . persistent water-in-oil emulsions which occur in circulating systems can be broken down by a demulsifying additive . . . . such agents should be chosen and used with care . . . .*

**by T. G. ROEHNER and E. S. CARMICHAEL**
SOCONY-VACUUM OIL COMPANY, INC.
BROOKLYN, NEW YORK

▲ THE records made by steel mills in meeting extraordinary wartime demands for quantity production without loss of quality stand on their own feet. A number of factors contributed to make those records possible. Experience has demonstrated many times that, without adequate lubrication, efficient operation of mill machinery is not possible and it may be reasonably concluded that lubrication is one of those many factors. Correct lubrication means not only the selection of the proper lubricants and methods of application but also maintenance of the quality of the products while they are in use. Under the heading of maintenance, the removal of water from circulating oils is often the most troublesome problem. The main objective of this paper is to discuss that specific problem. The separation of water from the oil used to lubricate the backup roll bearings of continuous strip mills may be given as an example.

Faulty seals and gland leakages are frequently the entrance points for water into the circulating systems. To avoid immediate shutdowns of the mills for repairs, water is sometimes permitted to accumulate in the oil until the percentages rise considerably above 5 per cent. Emulsions of the water in the oil are formed when the water is broken into literally millions of minute globules due to the dispersing actions of pumps, flow under pressure through constrictions in valves, squeezing under pressure in the bearings and gears, and like conditions. In some cases when the oil is allowed to settle in a properly designed tank, the dispersed globules will unite one with another to form larger globules and then slowly sink to the bottom where they may be drained off as practically clear water. In the troublesome cases, the droplets have various materials adsorbed on their surfaces which prevent or greatly retard coalescence. Then procedures other than settling may be necessary to clear up the oil.

Dependent on such variables as local preferences, available facilities and the stabilities of the emulsions involved, the methods employed include one or more of the following:

1. Dehydration by blowing the oils at temperatures above 150 F or by heating the oils to temperatures over 212 F.
2. Settling at temperatures varying from room temperature to 175 F.
3. Centrifuging above 100 F.
4. Use of demulsifier.

Dehydration by blowing the oils at elevated temperatures is sometimes used, but is not the preferred procedure because of the possibility of the lubricants deteriorating to an important extent under these conditions which favor rapid oxidation. It should be pointed out, however, that lubricants differ to a marked extent in their ability to resist oxidation and that a given oil might therefore not be seriously affected by infrequent dehydration treatments, whereas another oil under the same conditions might deteriorate to a marked degree. Mention might also be made of the possibility of the hot oil frothing out of the tank, which would of course depend primarily upon the amount of water in the oil and the temperature of dehydration.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

The two methods most commonly employed, singly or in combination, are settling and centrifuging. In the majority of cases they are effective in not only removing the water but also other foreign materials such as iron scale.

The fourth method, i.e., the use of demulsifiers in combination with settling or centrifuging, is the main subject of this paper. It is employed when settling and centrifuging are completely ineffective or require so much time that they are impractical. A few cases are encountered where the emulsions are so stable and have such structures that they will not crack (even during long time settling at elevated temperatures) and clog centrifuges so that that equipment becomes practically inoperative. By the application of the proper demulsifier, the emulsions may be cracked and the water released so that the batch may be thereafter treated by settling or centrifuging. With this procedure it has been found possible to accelerate greatly the demulsification of the water and in some cases it has been the means of avoiding shutdowns of the mills.

Before proceeding to a discussion of the use of demulsifiers, it may be of interest to review briefly some of the basic concepts of the emulsions to be cracked with demulsifiers. An emulsion may be defined as a system containing two liquid phases, one of which is dispersed as droplets or globules in the other. The liquid which is broken up into globules is referred to as the dispersed phase, while the other liquid is known as the continuous phase. In the case of a lubricating oil and water mixture, both liquids are subdivided on agitation. If the lubricating oil is in good condition and of the proper quality, and the water is quite clean, the dispersed phase, i.e. the water, will soon separate out when the mixture is allowed to stand in a settling tank. The formation of relatively stable emulsions depends upon the presence of a third component which is usually referred to as an emulsifying agent. Many materials are capable of functioning as emulsifying agents, such as fatty oils, soaps and iron rust. The fatty oils may originate with roll oils. The soaps may come from contamination with grease or by reaction of components of the water and oxidized oil. The iron rust may enter as scale with the water. When a mixture of lubricating oil, water and an emulsifier are agitated in a circulating system, either an oil-in-water or a water-in-oil emulsion will form. Substances which promote oil-in-water emulsions are generally water soluble, whereas substances which favor water-in-oil dispersions are essentially more easily soluble in oil than in water. A well known example of a water-in-oil emulsion is the ordinary lime base cup grease. A familiar example of an oil-in-water type dispersion is the white soluble oil emulsion used in metal cutting operations.

When stable emulsions are found in steel mill circulation oils, they are almost invariably of the water-in-oil type. However, it is quite possible to form multiple emulsions if the proper emulsifiers are present and the emulsification conditions are favorable. A multiple emulsion may be defined as one in which globules of the dispersed phase contain in turn globules of another phase. This has been determined by micro examination of samples removed from systems contaminated with mill water and roll oils.

In a discussion of demulsifiers to break emulsions, it is in order to cover the factors which determine the stability of the emulsions involved. There are a number of theories and a book could be written on that phase of the subject alone. However, for our purposes, relatively stable oil-in-water and water-in-oil emulsions may be considered as owing their stability to a combination of two factors, i.e., small size of globule dispersed and the presence of an adsorbed film on the globules which retards or prevents coalescence. This concept of an emulsion is illustrated in Figure 1 which represents a configuration of water globules in a water-in-oil type of emulsion. A represents a water globule, B the oil which is the continuous phase and C, the adsorbed film. Figure 2 is a photomicrograph of a used steel mill circulating oil magnified 440 times.

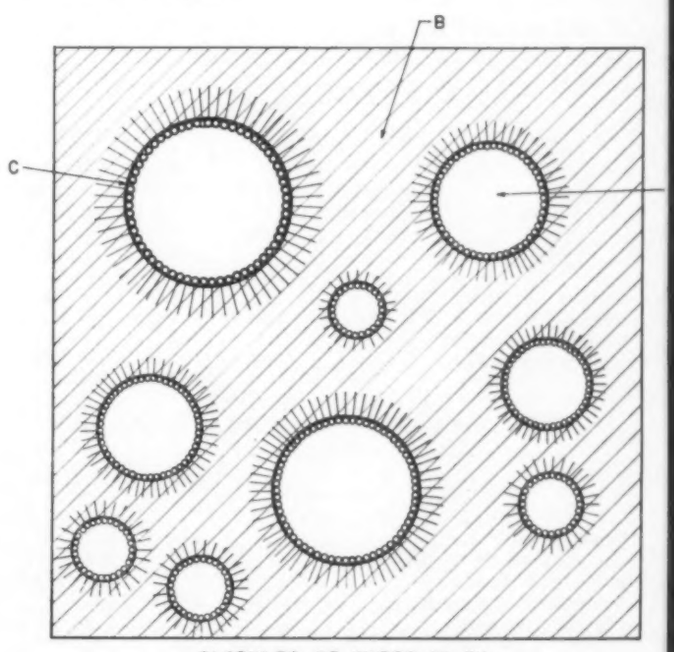
It should be emphasized that the mechanism of emulsion stabilization, as outlined above, has been over simplified because actually, at the water-oil interface, energy and electrical relationships exist which are decidedly complex.

Just as there are a number of theories which attempt to explain the formation and stabilization of emulsions, so also there are various theories which attempt to rationalize demulsification. They, in effect, back track on the steps which promoted stabilization. Several points which should aid demulsification are listed below.

1. Disrupting or destroying the adsorbed film on the globules dispersed.
2. Neutralizing the electrical charge on the globules.
3. Increasing the interfacial tension between the dispersed phase and the outside phase.
4. Decreasing viscosity by raising the temperature.

A demulsifier functions on the principle that it dis-

**Figure 1 — Sketch showing schematic concept of water-in-oil emulsion.**




GLOBULES OF WATER IN OIL

A-WATER GLOBULE, B-OIL, C-ADSORBED FILM

rupts or destroys the film on the water globules and thereby permits coalescence so that the droplets may grow to sufficient size to overcome the resistance of the oil and settle out or be removed by centrifuging. Experience has definitely shown that unfortunately there is no one demulsifier which will meet all requirements. They have to be selected with full knowledge of their composition and characteristics, because, if the wrong demulsifier is employed, the condition may be made more serious rather than improved. As pointed out earlier in this paper, the preferred procedures for demulsifying an oil are by settling and centrifuging. However, experience has also shown that when those two procedures are not practical, demulsifiers are available which may be safely used. To be safe, the additive should not only promote breakdown of the emulsion but, more important, it should have no adverse effect on the bearings and other metals, nor on the lubricating oil. In fact, cracking of the emulsion is often the easier part of the problem to solve. The problem is complicated by the requirement that the demulsifier be noncorrosive to the various metals found in the system, particularly to the bearings, and also not function as an oxidation promotor to the oil. No attempt will be made in this paper to discuss test methods for determining the suitability of a demulsifier in the latter respects. Further consideration will be given below to a procedure for evaluating a demulsifier with regard to its efficiency in facilitating removal of water from a used, circulation oil. In the course of the development of that procedure, it was found that the conventional methods for determining the suitability of a demulsifier were inadequate and often misleading. It was found that Herschel demulsibilities and steam emulsion numbers of contaminated oils of the viscosity ranges involved in steel mill circulation oils were frequently unaffected by the addition of small percentages of demulsifiers. This was not unexpected in view of the fact that the conditions of the Herschel and steam emulsion tests do not similate those encountered in service. The data shown in Table I illustrate the lack of significance of those two tests. Incidentally, experience has also shown that these tests have decidedly limited value even when run on new or unused oils. Two oils starting with equally satisfactory Herschel and steam emulsion values may vary considerably in demulsibility characteristics when subjected to identical service conditions. The difference would be due to differences in chemical stability of the two oils and the better of the two would be that which resisted oxidation and remained in new condition for the longer period of time. Moreover, both tests are so extremely sensitive that only a trace of oxidation, much less than that having practical significance, is sufficient to markedly change the results.

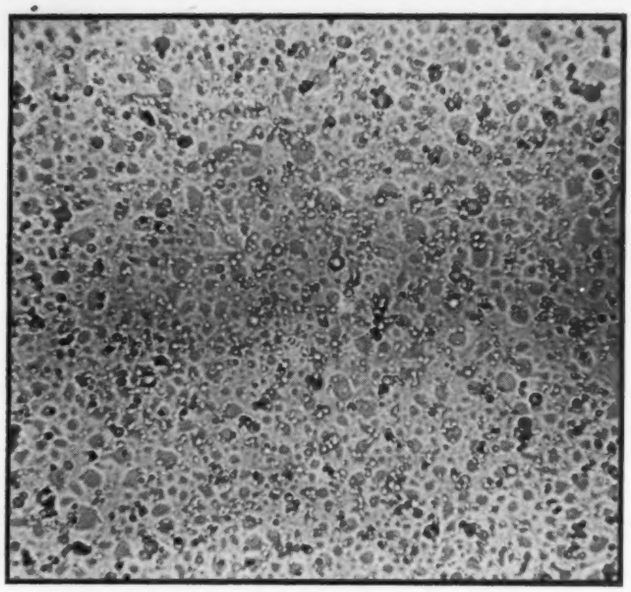


**Figure 2 — Photomicrograph of an emulsion of a used steel mill circulating oil (440X).**

## TABLE I

| Oil sample | Herschel demulsibility | Steam emulsion number | Per cent of total water that separated after centrifuging at | |
|---|---|---|---|---|
| | | | 100 F | 150 F |
| Unused mineral oil | 1620 | 320 | 85 | 100 |
| Used mineral oil | 100 | 1200+ | Trace | Trace |
| Used mineral oil plus 0.5% demulsifier A | 120 | 1200+ | 65 | 100 |

### TESTS ON UNUSED AND USED MINERAL OILS

| | Unused | Used |
|---|---|---|
| Gravity, °A. P. I. | 25.7 | 25.8 |
| Saybolt viscosity @ 100 F, sec | 2467 | 2407 |
| Color, A. S. T. M. | 7 | Dark green |
| Neutralization number | 0.05 | 0.7 |
| Moisture, per cent | Nil | 0.15 |
| Sediment, per cent | Nil | 0.07 |
| Nature of sediment | .... | Iron and iron oxide |
| Fatty material, per cent | Nil | 1.1 |
| Nature of fatty material | .... | Palm oil |

## TABLE II

| Oil sample | Per cent of total water that separated after centifuging at 150 F |
|---|---|
| Used mineral oil | 6.0 |
| Used mineral oil plus 0.5 per cent demulsifier A | 3.0 |
| Used mineral oil plus 0.5 per cent demulsifier B | 76.0 |

### TESTS ON USED MINERAL OILS

| | Used |
|---|---|
| Gravity, °A. P. I. | 25.5 |
| Saybolt viscosity @ 100 F, sec | 2452 |
| Color, A. S. T. M. | Dark brown |
| Neutralization number | 0.5 |
| Moisture, per cent | 0.3 |
| Sediment, per cent | 0.03 |
| Nature of sediment | Iron and iron oxide |
| Fatty material, per cent | Nil |

As previously pointed out, the addition of the wrong demulsifier may lead to the formation of even more troublesome emulsions. The procedure outlined below has been followed for several years and has yielded data which, when interpreted in light of past experience, will assist selection of the proper additive.

The equipment used in the subject test consists essentially of an homogenizer and a centrifuge, the latter revolving at 6000 rpm and developing a centrifugal force of 10,000 g. A photograph of the homogenizer is shown in Figure 3. As will be observed, the unit is a small circulation system in which a pump is installed. An oil-water mixture, consisting of 475 grams of the lubricant and 25 grams of distilled water, is circulated in the system for five minutes at 120 F. During this homogenization, the temperature is maintained by means of a heater, a fan and a thermal regulator, which are within an insulator box, as illustrated in Figure 4. After homogenization, the water-in-oil dispersion is withdrawn from the unit and 100 cu cm samples thereof are transferred into each of two centrifuge tubes. To the balance of the emulsion, the desired percentage of the demulsifier is added and the mixture is stirred either mechanically or by hand at 120 F until the material is thoroughly dispersed; 100 cu cm portions of the emulsion containing the demulsifier are also introduced into two tubes and the samples are centrifuged at 100 F and 150 F for a period of ten minutes. At the end of this time, the tubes are inspected and the percentages of clear, separated water are recorded.

It should be pointed out that the use of distilled water might appear to be open to criticism, since water of varying hardness is encountered in different mills. Although it is true that the presence of inorganic salts in the water and the pH value thereof may influence emulsion stability quite appreciably, the subject procedure will give a fairly good indication of the water-separating properties of the oil. It is to be noted in this connection that if the oil is already contaminated with water and a persistent emulsion exists, the demulsifier can be stirred into a small sample of the mixture at about 120 F and centrifuging can be carried out as described above.

In general, a deteriorated or contaminated steel mill circulation oil will form quite a persistent emulsion with water when homogenized by the subject procedure. Figure 5 shows the appearance of centrifuged emulsions of unused and used oils when the latter contains about 1 per cent of palm oil. It will be observed that, on centrifuging, the dispersed water coalesced quite readily in the case of the unused lubricant, whereas a viscous dispersion separated from the used oil.

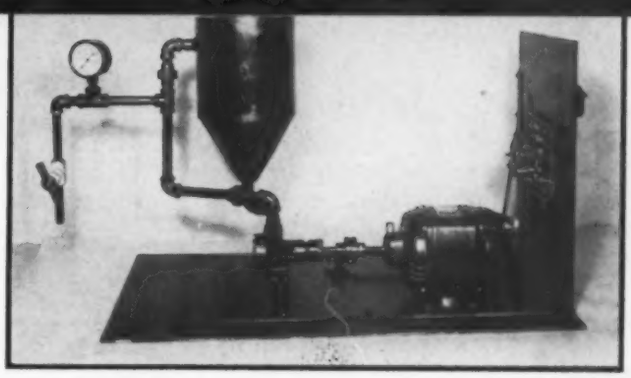


**Figure 3 — View of homogenizer unit with insulating box removed.**

▲

**Figure 4 — View of homogenizer unit with insulating box in place.**

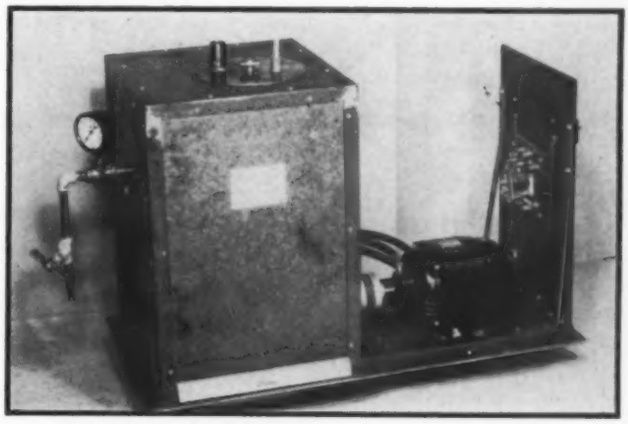
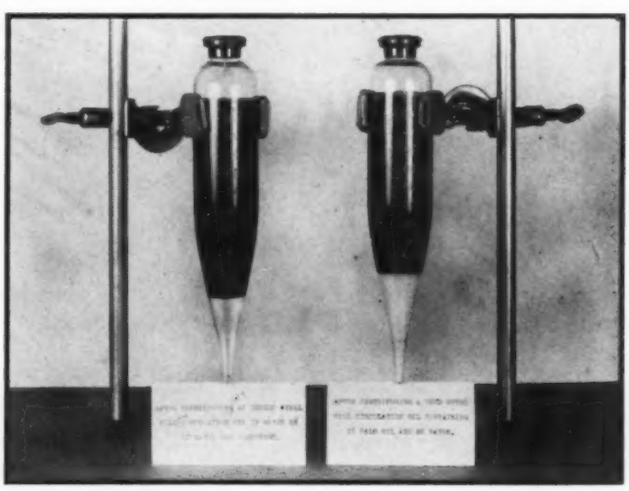


**Figure 5 — Centrifuged emulsions of unused and used oils.**



The efficacy of a certain type of demulsifier for this application will be noted in Table I. The used oil in this particular instance was removed from a large circulation system and had a Saybolt viscosity of about 2400 sec at 100 F. It will be noted that although practically all of the water separated from the unused lubricant, a persistent emulsion was present in the used oil which was not resolved by centrifuging. In the case of the same used lubricant containing 0.5 per cent of demulsifier A, it will be observed that a large amount of the water was removed even at room temperature. It is also of interest to note that the steam emulsion number and Herschel demulsibility were not appreciably affected by the addition of the demulsifier, even though the latter material was highly effective in breaking the emulsion.

Differences in the efficiencies of demulsifiers for this application will be noted in Table II. Demulsifiers A and B are of the same type and differ only in molecular weight. It will be observed that for the particular oil in question, demulsifier A was ineffective whereas demulsifier B broke the emulsion and caused most of the water to separate.

The question occasionally arises as to whether the addition of a small percentage of a demulsifier, such as demulsifier B, to a used circulation oil would afford

adequate protection against the formation of persistent emulsions for an extended period of time. Unfortunately, demulsifiers which are effective in breaking water-in-oil dispersions are at least partially water soluble and in time, depending upon the amount of water which contaminates the oil, are removed with the water.

In conclusion, it has been indicated in this paper that certain types of demulsifiers can be satisfactorily used for resolving persistent water-in-oil dispersions which are occasionally encountered in steel mill circulation systems. It has been suggested, however, that demulsifying agents be used for this purpose only when settling or centrifuging cannot be effectively employed. The importance of exercising extreme care in selecting a demulsifying agent for this application has been emphasized, since many materials which might be effective for breaking a given emulsion would be unsuitable because of corrosivity or deleterious effects on the lubricant.

## DISCUSSION

PRESENTED BY


W. H. MANDY, Lubrication Engineer, Texas Company, Pittsburgh, Pennsylvania

E. S. CARMICHAEL, Technical Service Division, Socony-Vacuum Oil Company, Inc., Brooklyn, New York

E. M. KIPP, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pennsylvania

H. T. KENNEDY, Gulf Research and Development Company, Pittsburgh, Pennsylvania

C. E. S. EDDIE, Assistant Superintendent, Steam and Fuel, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

MAURICE RESWICK, Engineering Division, Standard Oil Company of Pennsylvania, Pittsburgh, Pennsylvania

E. S. ROSS, Technical Representative, Sun Oil Company, Philadelphia, Pennsylvania

C. A. BAILEY, Lubrication Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana

P. J. DOYLE, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio


**W. H. Mandy:** I would like to ask if the demulsifier comes out with the water or does it stay in the oil after this separation? Also, how would you test the percentage of demulsifier remaining in the oil? There is such a small part, I imagine, in there that you wouldn't be able to detect it in the oil.

**E. S. Carmichael:** As pointed out in this paper, demulsifiers that are effective in breaking water-in-oil dispersions are at least partially water soluble. If, for example, half of one per cent of a demulsifier, such as demulsifier A, were incorporated in the oil and the oil subsequently became contaminated with 5 per cent of water, a considerable amount of the demulsifier would be removed with the water on centrifuging. The exact amount would depend upon the nature of the demulsifier and also upon the amount of water dispersed in the oil.

Under the conditions that have been indicated, using demulsifier A, approximately 50 per cent of the material would be removed on centrifuging. If at a later date that same oil became contaminated with more water, an additional amount of the demulsifier would be dissolved out, and eventually it would all be removed.

With regard to methods for testing the percentage of the demulsifier remaining in the oil, this can generally be accomplished by employing either chemical or demulsification procedures. However, it is usually difficult to determine accurately very small quantities of these materials.

**E. M. Kipp:** I am afraid this question is really out of order for this meeting but I would like to get Mr. Carmichael's opinion on whether the steam emulsion number value is an indication of any practical importance at all as far as the ability of an oil to retain moisture is concerned? That problem has come up in our company quite frequently with respect to transformer oils, and I know that many of the utility people do put quite a bit of stock in the steam emulsion number of the oil. The question in my mind is whether or not a steam emulsion number value determined in that way is of any practical significance or if it could better be determined by your method or some other chemical means of analysis.

**E. S. Carmichael:** The steam emulsion number undoubtedly has some significance. It indicates the tendency of water to separate from an unused oil. Generally speaking, when water is dispersed in a used lubricant by the steam emulsion procedure, that value is 1200+ if the oil has deteriorated to quite an appreciable extent. But the steam emulsion number doesn't give any indication of how the oil is going to hold up in service, and that is really what plant personnel are interested in. Two oils could have quite low steam emulsion numbers, quite high Herschel numbers, and still there might be a marked difference in the water-separating properties of those two lubricants after they have been in service for a relatively short time. In other words, lubricants differ considerably in their degree of chemical stability. Those lubricants that deteriorate at a relatively rapid rate will, generally speaking, show very poor water separating properties after they have been in service for short duration.

**E. M. Kipp:** If you take two used transformer oils both having a high steam emulsion number and treat them with activated clay, and in the case of one oil you bring the steam emulsion value down well below 1200 and bring the other properties, such as neutralization number, down to essentially as-new values, while with the second oil you do the same thing, bringing the other values down but leaving the steam emulsion number at the original high value, would you say the second oil actually would, in practice, tend to hold more water in permanent suspension than the first oil? I am starting with two used oils and treating each with a different clay.

**E. S. Carmichael:** As I understand your question, we are starting with two oils, both of which have a steam emulsion number of 1200+. Each of the oils is subjected to essentially the same clay treatment; in one case, the steam emulsion number drops way down, and, in the other case, it is unaffected. I would expect the water-separating properties of the lubricant having

the lower steam emulsion number to be appreciably better than those of the lubricant having a steam emulsion value of 1200+. However, it should be pointed out that the number of the former oil might very quickly increase to 1200+ again after being in service. This would depend in part upon the nature of the crude from which the oil was prepared. It all boils down to the inherent chemical stability of the lubricating oil itself.

**H. T. Kennedy:** The use of demulsifiers is a very complicated matter to discuss and I think, as the speaker said, we really should talk about demulsifiers specifically and not as a group. I should like to bring out one point. The speaker stated that demulsifiers should be used only in case you can't tackle a problem by centrifuging or other means. I think that is probably a matter of what demulsifier you use. In this area there has been quite a little experience with demulsifiers and there has been no trouble from corrosion or from any other source. As a matter of fact, by following the chemical properties of the oil, it is shown that the neutralization number and all other characteristics that are used as indexes of quality have improved steadily as the foreign material and perhaps the acidity have been washed out of the oil by the water which is separated.

**E. S. Carmichael:** We have indicated in this paper that demulsifiers can be satisfactorily used for this application. We do want to emphasize the fact that a demulsifier should not be added to a used lubricating oil unless that used lubricating oil has been tested with that particular material. It would be hazardous for plant personnel to employ "just any demulsifier," when emulsion troubles are encountered.

**C. E. S. Eddie:** I would like to add at this time a practical example illustrating what these two gentlemen are speaking about. We do not use any demulsifying agent in the active circulating oils of our 96 in. mill. Under normal conditions, our backup oil is not permitted to absorb more than 3 per cent of water by volume, but there are periods, i. e. when bearing seals fail or when the descaling jets are not positioned in the proper direction, that the use of the continuous mechanical centrifuge is found necessary. The separated water from the centrifuge generally contains, as in our case, about 17 to 23 per cent water-in-oil emulsion, which can only be effectively recovered through the use of a demulsifying additive such as Mr. Carmichael has described. This, in our experience, is the only successful method of reclaiming this oil for reuse in the mill circulation system.

**Maurice Reswick:** The question I had in mind was answered in part by the answers to the previous questions. What I had in mind was to ask whether there is any substance that you could add to a new oil which would reduce the tendency to emulsification, but I understand this is not possible and that every case has to be dealt with separately. Instead of there being three or four types, there might be a hundred or a thousand different kinds of demulsifiers.

**E. S. Carmichael:** That is correct.

**E. S. Ross:** I would like to ask Mr. Carmichael what effect the presence of demulsifiers in an oil would have on the electrical characteristics, such as dielectric strength.

**E. S. Carmichael:** Generally speaking, demulsifiers are polar materials and are ionic in nature. They will, therefore lower the dielectric strength of lubricating oils.

**C. A. Bailey:** An emulsified circulating oil system is not only a most troublesome problem, but one of the most annoying conditions that may be encountered by a lubricating engineer. The reason for this is that the lubricant suddenly changes in appearance so drastically that the condition is alarming to all those concerned.

The paper by Messrs. Roehner and Carmichael on demulsifiers is both timely and well presented. The large number of compounds that may be used with varied results indicates the need for an explanation of the basic theory. In our use of demulsifier compounds, the selection is empirical, and the most effective compound is selected for the oil in question by trial. One compound used extensively was not only effective in breaking the emulsion but produced effective separation of other suspended foreign particles held in solution. The same compound used on another emulsion produced no separation, thus confirming the theories set forth by Mr. Carmichael.

The conventional method of treatment is to remove the tank from service and heat to a minimum of 150 F and allow to settle for a period of days, depending upon local conditions. The subsequent centrifuging in the majority of cases separates the emulsion. In the event the emulsification is of a more permanent nature and does not respond to the first treatment, the situation becomes more alarming to personnel interested in the operating and mechanical condition of the mill. It is in these cases that demulsifier compounds play an important part in lubrication technology.

The use of various demulsifier compounds has resulted in detailed procedure required for effective separation. One in particular required the addition of water with circulation, temperature and time specified under definite prescribed conditions.

The compounds which do not require a detailed procedure but produce equal results are preferred by industry. The present design of oil circulating systems and the supply of trained personnel requires the simplest possible procedure.

The following question is directed to Mr. Carmichael and other members of this group. How serious is a permanent emulsion in connection with the film strength required for the emergency lubrication of mill bearings?

It is agreed that an emulsion is harmful to the chemical characteristics of a lubricant but have bearings failed during the time when the oil is under treatment when it is often necessary to operate several days on an emulsified oil? In one case a mill operated for several weeks under water conditions that could not be avoided. The oil in the emulsion collected from the water discharge of the centrifuge was recovered with the aid of a demulsifier compound.

An experiment has been performed with water and grease emulsions of various percentages combined by mechanical agitation and heat, with the film strength determined on a lubricant testing machine. The results revealed that 47 per cent water and grease emulsion continued to meet film strength specifications. However, it was discovered that the film strength was

maintained only as long as the emulsion was a homogeneous mixture. Immediate failure occurred when the emulsion became heterogeneous.

**E. S. Carmichael:** In my opinion, the addition of small amounts of water, that is to say, quantities less than 5 per cent, would have no marked effect on the film strength characteristics of the oil. When a water-in-oil dispersion is formed, oil is the continuous phase. Water is present as globules in the oil. In my opinion, the foregoing statement regarding film strength characteristics is true only if a homogeneous emulsion is obtained. If the emulsion separates into free water and oil, and water is actually pumped to the bearings, trouble will likely result.

In the case of a water-in-oil dispersion, we can't always be certain that we are going to have a relatively homogeneous system. The degree of homogeneity will depend upon the emulsifying materials present and upon the oil itself. One of the dangers involved in the use of an emsulsion is the possibility that it might "body up" to such an extent that it would be extremely difficult to pump in a system. Dispersions of water in oil, containing about 4 or 5 per cent water, have been observed which have been of heavy grease-like consistencies. Under certain conditions of homogenization, therefore, it is possible to produce a very viscous dispersion that might pump only with difficulty through the system.

**P. J. Doyle:** In most steel plants which have hot and cold strip mills with large oil recirculating systems for backup roll lubrication, the maintenance of the lubricating oil has been one of our major problems. As this paper has explained there are four methods usually practiced for the dehydration of these oils. Perhaps we in the steel plants are by far more familiar with the first three practices up to the present time.

In reference to these first three practices, I am of the opinion that settling of the recirculating oil at temperatures about 175 F or centrifuging above 100 F can result in quite successful dehydration if the oil has been properly maintained, that is, consistent removal by filtration, settling or centrifuging of scale, iron oxide, bearing metals and metallic soaps from the oil, as all of these materials act as powerful catalysts for the promotion of oxidation of the oil. These foreign components then react with the products of oxidation from the recirculating oil to form ideal emulsifying agents. Experience in the steel plants using large oil recirculating oil systems has shown that when these foreign materials have been kept to a minimum the recirculating oils will not be so susceptible to form extremely stable emulsions.

Now as to the fourth and principal method discussed by the paper the use of demulsifiers, perhaps all of us have been enlightened by the writers' explanation of the function of demulsifiers to accelerate the breaking of obstinate emulsions, and most of us may be of the opinion that this method will be extremely helpful in many instances where recirculating oil systems are employed, particularly these oil systems where water-in-oil emulsions are formed.

It is a practice in some steel plants to use soluble oil and various mixtures of soluble oils and fatty oils, as roll oils on cold strip mills. Therefore, if the bearing recirculating oil becomes contaminated with these solutions along with water, iron oxide and soaps, there may be the possibility of an oil-in-water emulsion being formed, along with the water-in-oil emulsion. Now where oil-in-water emulsions may be encountered, would the demulsifier satisfactory for the water-in-oil emulsion be beneficial in breaking down the oil-in-water emulsions to obtain complete dehydration of the recirculating oil?

I have asked this question because it has been stated that "a demulsifier functions on the principal that it disrupts or destroys the film on the water globules permitting coalescence of the water droplets." But the definition does not elaborate to the extent that we may believe the same demulsifier will disrupt or destroy the water film on the oil globules allowing coalescence of the oil droplets.

There is one more pertinent point I would like to bring out. You have stated, the demulsifiers used for water-in-oil are at least partially soluble in water, and are discharged with the extracted water from the oil. With this thought in mind, are the demulsifiers within themselves soluble in the recirculating oil, and if so, to what extent would they effect the recirculating oil over a prolonged period of use?

**E. S. Carmichael:** Water-in-oil dispersions can often be broken by using emulsifying materials that will stabilize the oil-in-water type of emulsion. Conversely (and I think this will answer your first question), if we have an oil-in-water dispersion, it is possible to break that dispersion by the use of a material that would tend to stabilize a water-in-oil mixture. In other words, a given oil-in-water emulsion could not be readily resolved by using the same demulsifier that is effective in breaking a water-in-oil dispersion.

Now with regard to your second question, the effect of the demulsifier on the lubricating oil with respect to its oxidation stability, and also the effect on metals in the system will depend almost entirely upon the nature of the demulsifier. That is the principal reason we have emphasized the importance of selecting the demulsifier with extreme care. In our opinion, if the correct demulsifier is employed, it should have practically no effect on the oil or on the metals.

**P. J. Doyle:** I would like to elaborate just a little on that answer. I asked the question with the thought in mind that by the continued use of this demulsifier you have a constant build-up of the demulsifier in the lubricating oil. Is that so or is it not so?

**E. S. Carmichael:** Demulsifiers should be used only when they have to be added to the oil. If, for example, half of one per cent of a demulsifier is incorporated in an oil and subsequent additions thereof are made without any appreciable amount being removed, the percentage of the demulsifier in the lubricant will eventually become quite high. This condition should be avoided.

If water difficulties are being experienced and a demulsifier must be employed, use the amount recommended. Do not go to abnormally high percentages.

I would like to make one further comment in that connection. One-half of one per cent of a material might act as a demulsifying agent. Two or three per cent of that same demulsifier might act as a stabilizer for emulsions. Care must therefore be exercised as to the amount of demulsifier that is added to the lubricant.

# Communication

# IN INDUSTRIAL PLANTS

*. . . . loud-speaker communication systems have been developed to meet the various noise conditions prevailing in steel plants and have been widely installed in various applications . . . .*

**by F. C. MILLARD**

PUBLIC ADDRESS ENGINEER

GRAYBAR ELECTRIC COMPANY

PITTSBURGH, PENNSYLVANIA


▲ THE subject matter of this article is based entirely on field experience and development through trial and error in some instances, and the conclusions drawn are based on actual working installations giving satisfactory service. It should be kept in mind that the equipment referred to is actually capable of delivering the results required and the manufacturer's rating of the apparatus is conservative rather than optimistic. There are many pitfalls in the design and application of communication systems in industrial plants. A brief explanation of the theory and a little historical background of high-level communicating systems in industrial plants will, it is hoped, be helpful as well as interesting.

When public address systems began to find general acceptance (which was about 1930, although they had been introduced some five years before), the idea of applying some modified form of public address systems for communication in industrial plants was tried out. At that time, equipment which had been made available for general use had not reached a suitable state of perfection or efficiency, resulting in some rather sad experiences.

In the early 30's, laboratory research produced a comparatively low voltage vacuum tube which, together with more efficient transformers, reduced the physical size and at the same time increased the power output and frequency response of amplifiers.


Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944


During this same time the laboratories developed the permanent magnet dynamic receiver unit, commonly called a loud speaker. Formerly, dynamic type of loud speakers required an external source of field excitation current, but the development of the highly efficient Alnico and cobalt steel magnets made it possible to produce loud speaker units requiring no external field exciting current or associated wiring, and having much greater power capacity and efficiency (see Figure 1).

While these developments were in progress, more knowledge of the function of the human ear had been obtained which in turn resulted in the development of equipment having greater fidelity than had previously been known.As a direct result of intensive research and development work for the Navy Department in the 30's, high-powered sound equipment was produced that made it possible to reproduce speech through very severe competitive noise, such as that encountered on the flight decks of air-craft carriers. It was not until 1939 that equipment practically suited for use in industrial communication was available. However, the demand for such a form of communication had existed all the time and was constantly growing.

Because of this demand, numerous attempts to make existing types of equipment work under industrial conditions were made by various companies, with the result in many cases of complete failure. These failures

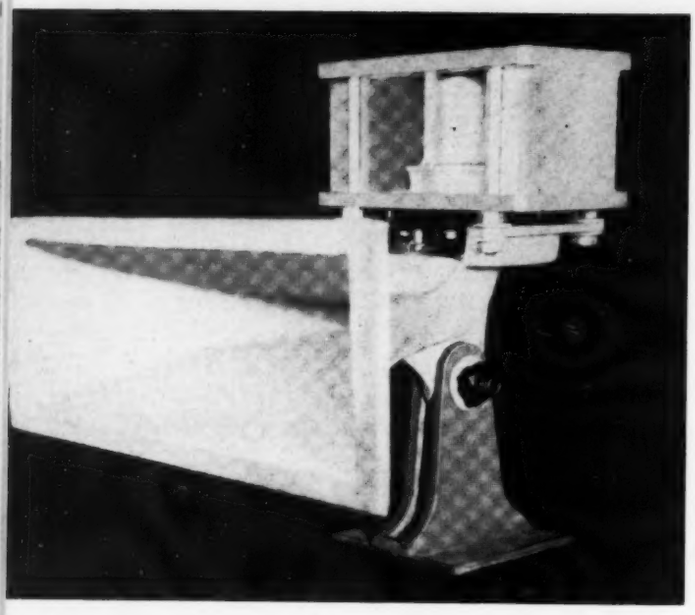


**Figure 1 — High efficiency permanent magnet receiving unit with special narrow beam horn.**

were directly the result of not using equipment of proper design to meet all the requirements for such systems.

The first requirements for any communication system under any situation is intelligibility. To provide a system of communication that will meet the conditions encountered requires consideration of a number of factors. The term "intelligibility," as used here, is intended to mean the reproduction of speech in such a manner that it may be clearly heard and understood, even though interfering competitive noises are present. A communication system used for interoffice purposes may have adequate intelligibility when used as an interoffice system but it will be totally inadequate when used in industrial system where competitive noise exists, simply because it does not have the inherent ability to provide for intelligible reproduction under noise conditions, for reasons that will be explained further on.

Competitive noise may be considered as any sound that will interfere with the clarity of reception on the part of the listener. Competitive noise may be caused by:

1. Inherent background noise in the communication system itself.
2. General mill noises which exist at that point where communication begins.
3. General mill noises which exist at the point of reception.

Conditions 1 and 2 can be satisfactorily eliminated by the use of properly designed equipment, and while condition 3 cannot be eliminated, it can be overcome with few exceptions.

The answer to the elimination of unwanted background noise inherent in the equipment itself is the use of dynamic type microphones rather than the carbon-button type (see Figure 2) and an amplifier designed for high fidelity reproduction so that its inherent noise level is well below the threshold of audibility (see Figure 3). It may be argued that the presence of background noise in the amplifier is unimportant because the system works under noisy conditions. The fact remains that any parasitic noises in the system itself require more signal strength to over-ride these noises, thus decreasing the effective usefulness of the amplifier. At the same time, it has become the practice to install what we call "low-level" stations at some points along the line of communication, such as general superintendent's, master mechanic's, recorder's and other offices where the mill noise is not severe and background noise inherent in the system would definitely be audible and annoying.

The elimination of noise which is present at the point where communication begins is a matter of equalizing to provide for sharp attenuation of low frequency mill noises which may enter the microphone along with the voice of the person speaking and to provide a rising characteristic to the wanted signals so as to accentuate the higher frequencies. In this connection we have found it possible to originate a conversation within 10 ft of a 6 ft diameter hot saw, where the noise present was so great that you could not hear your own voice as it entered the microphone; yet at the point of reception some distance away from the hot saw the voice of the person doing the talking is reproduced without serious background noise.

Reference is made above to condition 3, which is the noise existing at the point of reception, and while this condition cannot be eliminated, it can be overcome in most instances because it involves an acoustic problem, as well as the human equation of hearing. Generally, noises of the greatest peak power which are encountered in industrial plants are those sounds which have their fundamental frequency below 250 cycles. Of course, added to these fundamental frequencies are the harmonics and overtones, but as the pitch goes up the intensity falls off so that we may say that, in general, mills or industrial noises have a falling characteristic, meaning that the higher the frequency, the less its intensity.

It so happens that frequencies important to good reproduction of speech lie in the higher octaves and the human ear requires for intelligible listening a rising characteristic toward the higher frequencies. This is especially true where a severe competitive noise is present.

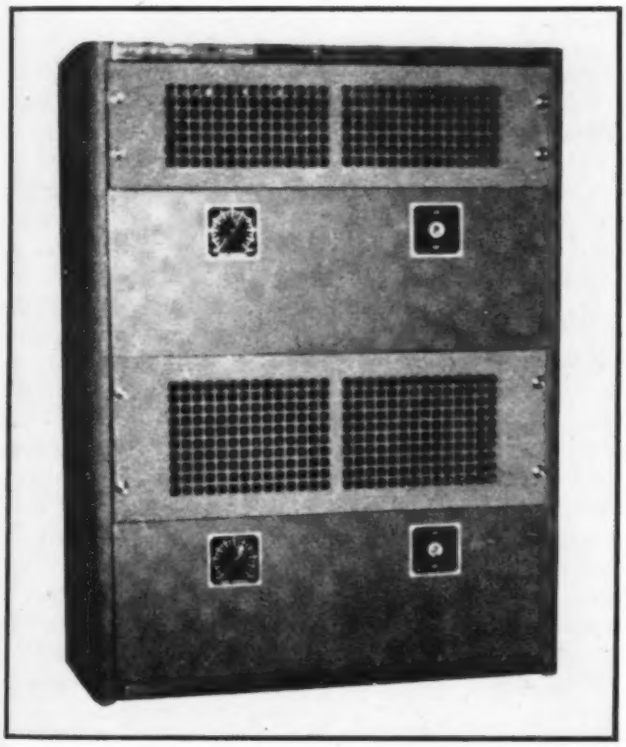
The average human ear responds best to frequencies in the neighborhood of 1400 cycles, and while it would be possible to understand speech having a range of from 100 to 1400 cycles, competitive noise of reasonably low amplitude would penetrate the listener's ear to such an extent that he would be aware of a signal but would be unable to understand it if the response were only carried to the peak efficiency of the human ear.

It has been shown that the higher the frequency response, the greater the intelligibility of the signal, whether it be speech or music. This is particularly true where severe noise levels are present. One of the best illustrations that can be offered along this line is the current advertisements that are appearing in connection with FM (frequency modulation) broadcasting. These advertisements stress the fact that FM provides greater detail and "tone color," which is another way of saying intelligibility; thus, in high-level communica-

**Figure 2 — Industrial type of dynamic microphone.**

▲

**Figure 3 — Two amplifiers mounted for industrial use.**



tion in steel mills, the more detail we can create in the reproduced signal, the less will be the masking effect of the competitive noise at the point of reception. A system that is capable of reproducing frequencies with rising response up to 8,000 cycles may be operated under noise conditions where a system that will only reproduce frequencies up to 4,000 cycles could not provide satisfactory service. It is essential that all elements in the system be capable of the frequency response required; otherwise, the entire system will only be equal to the response of the poorest piece of apparatus used. As an example, some years ago we used high quality microphones and high quality loud speakers on a small two-way, two-station installation where a low powered amplifier was adequate to energize the loud speakers to a suitable acoustic power. For the amplifier in this system we used one of the commercially available interoffice communication system amplifiers, and while it produced enough acoustic power through the loud speakers, the system was totally unsatisfactory for the reason that the amplifier had a falling response at frequencies above 4,000 cycles. It was possible to hear the system working but impossible to understand what was being said. To correct the situation, a high-fidelity amplifier was added with the result that the performance of the system was perfectly satisfactory. In other words, when we used the interoffice communication amplifier, the whole system had no better response than the amplifier itself; yet this same amplifier used with microphones and loud speakers of comparable quality in an office installation will deliver perfect satisfaction, the difference being that the amount of masking noise is an office is not at all comparable to that encountered in a mill.

In our mill communication systems where an office station is desirable, we use a less expensive and less efficient loud speaker having a comparatively poor frequency response simply because the low competitive noise makes such a piece of equipment adequate (see Figure 4).

## APPLICATIONS

There are two principal fields of application for public address equipment in industrial plants, namely, paging and intercommunication. Plants which are spread over a large area of construction projects, find the one-way paging system advantageous for locating key people. Usually the telephone operator makes the call and the party being called responds by going to the nearest telephone extension and communicating with the operator. A paging system which does not provide adequate coverage or good intelligibility in the areas being served is not successful. It is necessary, therefore, to select the type of reproducers best suited to the areas being served. A greater amount of amplifier power is necessary in a paging system than is required in a communication system because the areas being served are usually much larger; likewise, proper consideration must be given to the dispersion angles of the loud speakers being used so that uniform distribution of all frequencies can be obtained. Paging systems which provide distribution of sound at the higher frequencies over a very narrow arc are only intelligible if the listener is directly on the axis of the speaker. For this reason a loud speaker having uniform frequency response over its dispersion angle should always be used.

Intercommunication systems must provide for the origin of a signal in either a quiet or noisy area and its reproduction under the same conditions.

A complete list of the various uses to which high-level intercommunication systems have been applied would be too lengthy for this article; however, a few of the more commonly used types and some of the novel applications of this system will be described here.

*Rolling mills* — These mills generally use intercommunication systems having the most stations, starting with the soaking pit recorder and going all the way down

through the mill, taking in the various operating pulpits up to the cooling and gauging tables. In a mill where rolls are changed frequently the roller may go out to the cooling table, gauge the material, and if any changes are necessary he can instruct his assistants by direct communication rather than walking back or sending a tab boy. Installations in rolling mills with 11 stations have made it possible to release for other work as many as 15 tab boys. The advantages of every person at an operating point along the line being able to communicate instantly with any other or all points are obvious. These systems generally are supplied as "common talking," which means that every station on the system will hear all conversations between any of the operating points.

*Continuous mills* having a remote electrical circuit breaker and relay board find the use of these systems invaluable. Usually a mill will have three stations along the line and one in the contactor room. When a system of this type is provided and installed with the mill, the time saved in setting up the mill and synchronizing its operation is usually more than enough to offset the cost of the equipment, and systems applied in this manner are particularly valuable when maintenance on the mill is necessary.

*Bessemer converters* have been equipped with selective systems so that the operator in the pulpit may communicate directly with any point desired. These systems are made selective to eliminate the possibility of confusion or misunderstanding, although the control panel is so designed that by operating a key the entire systems become "common talking." These systems are also arranged so that if there is a conversation going on between the pulpit and one of the stations, any other station may call in to the master station in the pulpit and not be delayed by a "busy line." It is also possible for the operator at the master station to set up his keys so that any two stations may converse directly with each other, both sides of the conversation being heard at the master station.

*Blast furnaces* — Intercommunication between cast floor and various operating points has proved extremely useful. The work of relining blast furnaces has been considerably speeded up by installing temporary equipment between the scaffold inside the furnace and the hoist men outside on the ground.

*Soaking pit buildings* — Pit recorders can talk to crane operators and issue instructions over one-way systems that have been especially designed for this purpose.

*Supervision* — Mill superintendents find it desirable to have a monitoring station in their office, which they may turn on or off. If there is more than one system in the mill, a monitoring station is provided for each system. This permits quick contact from the superintendent's office with any of his assistants along the mill line and by monitoring the conversations through the system, the superintendent is immediately aware of any unusual trouble that may develop, and may either issue instructions from his office or go to the scene of the trouble and still maintain contact with his office through the intercommunication system.

*Crane systems* — The problem of communication between the ground and the operator of a crane cab is fairly easy to solve if the crane is under construction

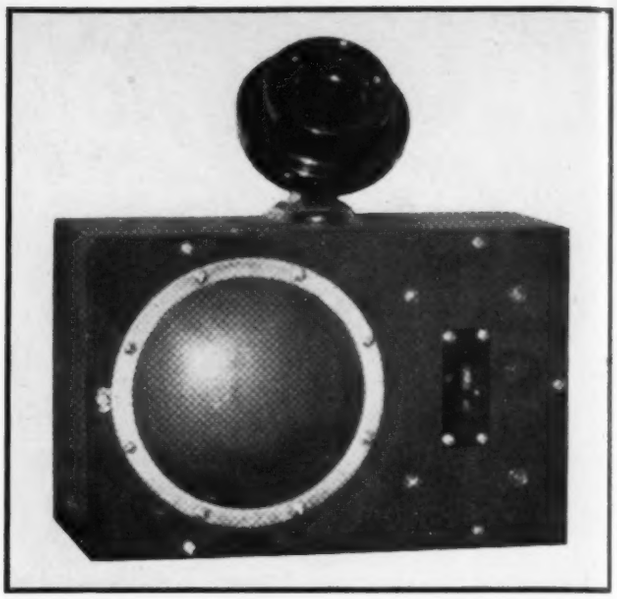


**Figure 4 — Low-level office station, showing speaker, microphone and "press-to-talk" key.**

and additional collectors may be built into the collector system. We have provided communication systems on hammer-head cranes with two-way communication to all of the operators and a ground station. Similar systems have been provided for car dumpers or car loading rigs with stations on the ground, portable stations for the dock foreman in the case of ore handling equipment, and stations in each of the operating cabs. Ore bridges may be equipped with two-way communication between all operators' cabs on the bridges and ground stations. All of these systems, however, require the installation of a special collector system, and in the case of existing crane equipment it is not always practical to do this. Various attempts at communication by means of two-way radio transmitters and receivers have been made. The disadvantage to such a system is that unless the radio equipment is built for severe service, numerous failures will occur, and if the equipment is built for the service intended, its cost is usually prohibitive. It is entirely possible that in the near future, radio equipment suited to this application will be available. Such equipment will, to be practical for industrial use, have to be rugged so as to be reasonably free of maintenance.

*Coal tipples* — The severe noise in coal processing and washing tipples has made high-level communicating systems the practical answer to communication problems between the various operating points, such as pump house, main control room, scales, car loading chutes, etc.

*General* — Sometimes it is undesirable for an operator to leave his station to communicate with an associate operator even though they may be separated by only a few feet, and we have one instance where equipment has been installed to provide for communication between two men who are less than 10 feet apart. One of these men cannot take his hands off the controls for switching the "press to talk" key, so it has been arranged for the man at the other station to do the

switching. Thus, these two people can communicate with each other and remain at their stations.

Installations have been made where the noise level is so severe that operating people cannot converse with each other even though standing face to face, so they use the high-level system to amplify their normal speaking voice and converse with each other in this manner.

It is possible to provide a tone signal through these systems for alarm purposes or code signaling. This is accomplished by modifying the amplifier with a tuned resonant circuit that may be closed with a relay, causing one of the amplifier stages to oscillate and generate a sound of any desired pitch.

High-level communication systems as described here will not replace other forms of communications such as Telautograph, selsyn indicators, or forms of code signaling such as whistles, bells, lights, etc., but it will supplement any or all of these forms of communication and provide a means of instantaneous oral contact to important operating points without the necessity of the operators leaving the control stations.

## EQUIPMENT

The apparatus selected for use on any communication or paging system must be suited to the application for which it is intended, and while there is a basic standard of performance common to all of these systems, the individual units of apparatus may differ considerably. Reference is made above to low-level stations located in offices as compared to high-level stations located in noisy areas. In general, the office stations are all of the same type and they have the ability to reproduce enough sound to cover the average office situation. The loud speakers used in plant areas must be selected for their ability to perform in a certain location. The loud speaker which will serve the purpose in a roller's pulpit will not always be successful if used out on a mill floor.

Loud speaker units vary in efficiency, which is the ability of the unit to transfer electrical energy from the amplifier into acoustic energy and deliver it to the horn. It is less expensive to use a highly efficient loud speaker unit than it is to supply amplifier power because the amplifier requires periodical maintenance in replacement of vacuum tubes, and of course the more tubes there are to generate power output the greater the maintenance potential.

Industrial installations serving noisy areas cannot successfully use the paper cone diaphragm type of loud speaker for several reasons, the principal ones being that these cannot be coupled to a horn having a uniform dispersion angle of sound at all frequencies. The cone type of loud speaker is comparatively low in efficiency and has a falling response at the higher frequencies, making it unsuited for good intelligible reproduction under noisy conditions. It is true that there are paper cone loud speakers which have been "corrected" to provide for extremely high frequency response, but this correction substantially reduces the general efficiency of the unit, and even though sufficient amplifier power were available the power handling capacity of the paper cone unit is limited, making it impractical for this type application.

The metallic diaphragm type of unit having a highly efficient permanent magnet is the real answer to high-level communication. It must be kept in mind, however, that not all metallic diaphragm units provide the frequency response necessary for good performance under industrial conditions. Uniform response to at least 6500 cycles (or higher) is essential.

The common talking system usually is operated by using a lever type key closely associated with the microphone at each station. This key is arranged for spring return to normal or receiving position, where it remains unless the operator at that point wishes to talk, at which time he presses down the lever key while speaking into the microphone. Naturally these keys receive considerable use and are not always handled too gently;

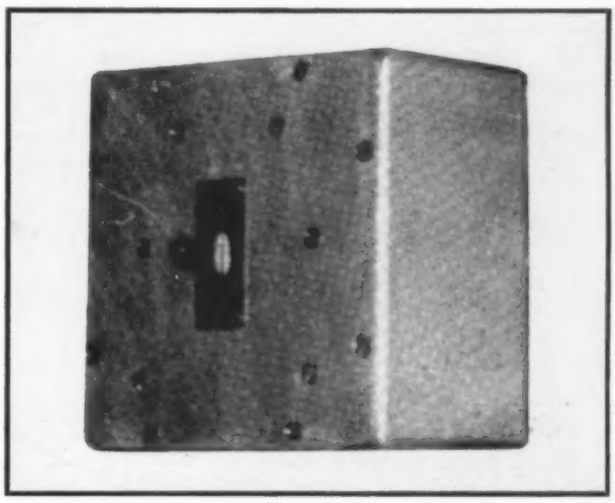


**Figure 5 — Lever key mounted in dust-proof steel box.**

therefore they must be of rugged construction with a spring arrangement that will continue to provide positive contact under long and severe use (see Figure 5).

## SYSTEM PLANNING AND INSTALLATION

When planning an intercummunication system it is well to consider the simplest form of installation for minimum maintenance potential, and at the same time any possibility of future expansion of the system by the addition of more stations should be kept in mind so that sufficient amplifier power will be available to drive such additional stations as may be added without changing the amplifier. While the system as originally installed with only a few stations may have more amplifier power than is needed, this reserve power contributes to distortion-free reproduction and therefore does no harm. We have seen installations have initially only five stations grow until they have as many as seventeen, but with this expansion in mind originally it was only a matter of providing additional wiring between the points and adding the additional apparatus required for each station.

The general design of any communication system should be such that it may be installed with a minimum of wiring and other installation details. Proper design

of the complete electrical system makes it practical to install the systems described here by the use of two main transmission lines in the case of common talking equipment, and where these transmission lines are installed in conduit for mechanical protection or other reasons only a single conduit is necessary.

The cost of installing a system is in a good many cases more than the cost of the apparatus used; therefore the installation becomes a primary item and any savings that can be effected by the design of the general system are important.

Good workmanship in the installation of the wiring is also important. Because of the electrical design of the complete system, the electrostatic shielding required on the individual pairs of wires must be carried throughout the system and the phase relation of the wiring must be kept the same throughout. The principal difficulties in getting these systems to work properly are usually traced to indifferent workmanship in the installation. Where a good installation is made, the systems are usually free of trouble from the start.

It is not practical to install this equipment with standard telephone cable because it is necessary to electrostatically shield the individual pairs of wires; otherwise the energy transmitted through these circuits would cause cross talk through other pairs of the telephone cable, in addition to the possibility of the insulation of the telephone cable breaking down because it is not designed for this type of service.

With industrial plants finding so many uses for electronic equipment, a good vacuum tube checker is an important piece of maintenance equipment to have on hand, as well as an a-c rectifier type voltmeter having a range of from 10 to 1000 volts and a resistance of not less than 1000 ohms per volt. A periodical check of vacuum tubes is desirable and a log of such tests should be kept. Where periodical tests of vacuum tubes are made, it is possible to anticipate tube failure and replace those that show signs of becoming weak before they give out entirely.

Vacuum tubes which are used continuously are giving many times more hours of service than their rated life. There are numerous reasons for this, all of which are too involved for discussion here. Plants having several communication systems in service have found it desirable to have on hand a spare amplifier and replacement parts for microphones, control keys, loud speakers, etc.

## CONCLUSION

The systems described here are not wartime developments. In fact, the war has seriously handicapped efforts in this field by creating equipment shortages and retarding development work. Manpower shortages and the war necessity for speeding production have accelerated the acceptance of these systems generally. Many items of equipment now being made for military use exclusively will be released for general use after military requirements have been satisfied. A highly efficient metallic diaphragm loud-speaker unit with weatherproof horn is one item, and improved microphones and other items will also be available. High-level communication systems will have a definite place in post-war production because of their economic value.

Any credit for the development of high-level communication systems must be shared with those plant engineers who were open minded enough to allow trial installations to be made when the general idea was new and had not proven its value. In addition to permitting trial installations, the plant engineers and operating superintendents contributed many suggestions which were invaluable in the application of these systems now in use. It may be said, therefore, that the communication systems described here are for steel mills and were actually perfected by steel plant engineers.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# Telautograph

# COMMUNICATION SERVICE

*. . . .[instantaneous communication between certain points in steel plants is of vital importance . . . . visual methods offer advantages of accuracy and a permanent record . . . .*

**by WHITNEY HAYES**

TELAUTOGRAPH CORPORATION
PITTSBURGH, PENNSYLVANIA

▲ TELAUTOGRAPH service consists of the leasing of equipment by the TelAutograph Corporation which provides communication between various points instantaneously, and in handwriting. The points of sending and receiving may be located in one building, in some of a group of buildings, between points in a city, or between nearby cities. We limit ourselves to a distance of approximately 25 miles. In other words, the loop resistance of the wires between stations is limited to 2400 ohms or less. In a system of, say, 10 machines, it can be so arranged that any station can write to any other, to any group of the others, or to all of the others, at one writing, by means of selecting devices.

It is very simple to write on the telescriber. No experienced operator is required. The writing is done by a stylus on a metal platen. The pens at the writing instrument and at the receiving instrument or instruments describe the same characters as the writer does with his stylus. Thus, if he makes a figure S with the stylus, the pens on the instruments make the figure S in ink on continuous rolls of paper 5 in. wide. When the writing field is filled, the writer shifts his paper by pushing a button with his stylus and the paper on all receiving machines connected automatically shifts at the same time.

This method of communication is used quite extensively in the iron and steel industry, where immediate written transmission of information, such as chemical analyses, pit charging schedules, and rolling information is so important. Telescribers transmit this vital information instantaneously, with absolute accuracy, and the reception of the information is not affected by the high noise level in mills.

Every steel mill order has definite specifications which incorporate stated requirements for carbon, manganese, phosphorus, sulphur, silicon, etc. to be contained in the steel furnished. The planning department assigns the specific heats to be manufactured in certain open hearth shops or bessemer converters.

When the molten iron is run out of the blast furnace into casts to be sent to the mixer, a sample is sent to the laboratory for analysis. When the analysis is made, the chemist writes it, with identifying cast number, on his instrument and it is immediately received at the blast furnace, mixer and possibly the open hearth and bessemer. Thus, the analyses are transmitted instantaneously and accurately to the interested points, and

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

**The telescriber and the writing instrument may be separated for protected mounting of the latter, as shown above, or they may be combined into a compact unit as shown below. The length of exposed record may also be adapted to the needs of the application.**

there is no delay in production due to waiting for analyses.

When the open hearth or bessemer takes iron from the mixer, they know the quality of the iron and can judge what practice to use to make the steel to specification. When the melter judges his steel to be ready for preliminary or final checks, he sends a sample to the laboratory. The laboratory again makes preliminary or final analysis and sends it, via TelAutograph, to the furnaces in question and perhaps also, in the case of a final analysis, to the soaking pits, scales, blooming mill, mill recorder, planning department, billet and bar mill, etc. It is important that the melter receive preliminary analyses quickly, for the ever changing chemistry of the steel will make a greater difference, the longer the time between the sample and the analysis report.

The planning department wants the analysis quickly to determine whether the chemistry is up to the standard required by the specifications. Upon determination of this, the heat can be passed, stocked as ingots, applied to another order, or rolled and placed in stock. In some mills, it is necessary that the soaking pits and scales alter their tally sheets to show that a heat is reassigned — thus, they get the analysis to forewarn them that they will expect a reassignment.

When the planning department reassigns a heat, the open hearth requires the information so that they know they will have to make up another heat to fill the order on which they failed in the first attempt. The pits and blooming mill need this information so they can change their schedule accordingly, and apply and route the steel accordingly, when it reaches them.

The soaking pit is often connected with the mill recorder, the roller, and the shears, so that they can be notified when a heat is drawn from the pits. Thus, the recorder has a record of the ingots passing through the mill, and can prevent mixing of ingots and heats. Also, the roller and shear men know definitely what ingots are being sent them, and they can roll them and shear them to correct sizes.

Through such a system, the coordination of effort and the unified control afforded over the cooperating departments in a steel mill are speeded up, and all individual units work together as one piece of directly connected machinery, giving forth a maximum output from available material, equipment, and manpower.

Another great use of TelAutograph service, is in transportation procedures. There are certain points in a steel mill of even moderate size where the activity of switch ordering is great. These orders are usually handled by either walking or phoning them in to the yard office. If they are telephoned, they should be followed by written confirmation. TelAutograph service, as used in this application, provides transmitters at the ordering points and receivers at either a transportation coordination office or at the yard office. If the mill has more than one yard office, it is usually better to provide an intermediate coordination point to reroute the orders to the proper yard office.

Supposing a mill handles an average of 500 switch orders per day. You can imagine the wasted time and errors that would result from either walking or phoning these orders to whatever yard office was deemed proper. However, with TelAutograph transmitters at the points of heaviest activity, this wastage is eliminated. This system puts all switch orders in writing as to location, time, capacity, etc., so that there is no argument between the mill and transportation people. It saves a great deal of time over oral contact because the ordering points do not need to wait for an answer. They write the order and are through, for they know that their order has been transmitted accurately and instantaneously. At the receiving end, it saves the constant breaking in on routine work caused by answering telephones, etc. It leaves the telephones free for the calls from those points not having enough activity to justify the installation of TelAutograph service. Thus, the preponderance of switch orders are transmitted in writing — accurately and efficiently — and the control achieved tends to decrease demurrage, and engine hours, and man hours.

There are many other applications for this service in the iron and steel industry, in applications wherever transmission of definite and specific information, orders, etc., with the utmost accuracy and speed, is vital.

# Ore and Coal Handling

## ON THE LOWER LAKES

*. . . . efficient handling of the bulky raw materials has contributed much to the economy of steelmaking . . . .*

**by A. E. GIBSON,** PRESIDENT
THE WELLMAN ENGINEERING COMPANY
CLEVELAND, OHIO

▲ OF all the many and varied natural resources found in the United States, the huge iron ore deposits of the northern Lakes region have played the greatest part in its industrial development. Through remarkable coincidence, this vast deposit is situated at the head of the greatest inland waterway in the world, making its transportation cost exceedingly low.

The discovery of ore in the Lake Superior District dates back to 1844, but shipment of ore down the Lakes started in 1852. The locks at Sault Ste. Marie had not yet been built and shipments in those early years were small, the first ones having the ore loaded in barrels since the ships had to be unloaded and the ore hauled around the rapids by horse and reloaded into ships below the rapids. The opening of the Sault locks in 1855 made possible the uninterrupted shipment of ore and marked the real beginning of its water transportation.

For a period of eleven years following 1855, no mechanical equipment was used in unloading boats. Staging was built in the hold of the ship, the ore was shoveled onto it and again from the staging to the deck, where it was re-shoveled into wheelbarrows and wheeled onto the dock. Ore cargoes then ran about 300 tons and required approximately four days to unload. In contrast to that, today one modern unloader can handle that tonnage in something like fifteen to twenty minutes.

The next step in development of unloading was the use of horses hauling a manila rope reaved to the ship's rigging and attached to a tub of ore still shoveled by hand. The ore was wheeled in barrows as usual after being hoisted out of the ship.

In 1867 the first application of mechanical power to unloading resulted from the ingenuity of Robert Wallace who designed and built a 6 x 12 in. steam engine geared to winding drums. This was a portable rig which could be moved along the dock. The application of power to hoisting permitted the handling of three tubs of ore at one time and cut the unloading time to one day. This method was in general use until 1880. It is estimated that the cost of unloading was 40 to 50 cents per ton.

The next development was the installation of cableways, bridges and revolving derricks, the latter known as whirlies with which self-dumping buckets were used for dumping ore into cars or on stock piles.

In 1880 A. E. Brown interested himself in the promising ore industry, or at least in that part of it having to do with the unloading of ships. His company installed three mechanical ore unloaders on the N. Y. P. & O. docks in Cleveland, Ohio, and these delivered ore from the hold of the ship to cars or stock piles without rehandling. These rigs consisted of two towers, one at the rear of the stock pile, the other on the dock, with a cableway stretched between them. A hinged boom attached to the front tower could be lowered, thus carrying the cable over the boat. A trolley from which a bucket or tub was suspended traveled on the cable. A 12 x 24 in. steam engine coupled to three clutched

Presented before A. I. S. E. Cleveland-Youngstown District Meeting, Nov. 20-21, 1944.

**Figure 1 — Combination of unloaders and bridges at a large blast furnace plant having lake facilities.**

drums furnished the motive power for each of the three rigs. The cableway was 383 ft long, 75 ft high at the rear and 61 ft at the dock. The height of the operating cable at the dock was 28 ft.

This mechanism, by permitting the carrying of the ore tub out of the ship for loading into cars or onto the stock pile without rehandling, naturally reduced the unloading time of the boat very materially.

Shortly, after Mr. Brown's first venture, Robert Aspin built, for the Illinois Steel Company, rigs known as the Champion hoists. These consisted of a stationary tower supporting a shear leg, which could be raised and lowered to permit a tub of ore to be hoisted from the hold of a ship and brought to the dock so the ore could be dumped into wheelbarrows or tram-cars. In later rigs the ore was dumped into a hopper with gates from which it dropped into cars. Unloading with this type of equipment was so efficient that it was not replaced until 1906, at which time new and modern unloading machinery was installed.

Two years after Mr. Aspin's unloading venture at Chicago, another Clevelander entered the field. John McMyler applied the revolving derrick or whirley, as it was commonly called, to the unloading of ships. They were a clattering collection of reversing steam engines, clutches, and drums. However, they were fast, and in the hands of an experienced engineer the operating cycle ceased only for the few seconds when the hook was shifted from an empty to a loaded tub in the hold of the ship. A good operator dumped the bucket into the waiting gondola or hopper car on the run. Even today, where small tonnages are handled, the whirley has survived competition. They were the early vintage of the revolving crane one now meets so often in industry.

**Figure 2 — This bridge, which is used for both unloading and stocking, has a lift boom at the unloading end. Open portal in pier leg permits movement of cars.**

In 1888-89 ore unloading equipment was revolutionized by two developments. One was the introduction of bridge type unloaders equipped with clam-shell buckets. Previous to this date the ore was still shoveled by hand. The early clam-shell buckets were of small capacity, one or one and one-half tons. They were the first mechanization of the industry which eliminated the hard labor of hand shoveling. Clam-shell bucket handling of ore has continued in use since its innovation and capacities of buckets have increased from the original one ton to over 23 tons.

The other development coincident with clam-shell bucket unloading resulted from the invention of the stiff leg unloader by G. H. Hulett. Ignoring all that had gone before, Mr. Hulett attacked the problem of ship unloading from an entirely new standpoint.

His machine consisted of a self-propelled gantry spanning the tracks along the docks, on which was mounted a trolley traveling at right angles to the ship. A walking beam was pivoted at the top and forward end of the trolley. At the water end of the beam, a bucket leg

was suspended. The leg extended above the walking beam and to the top of the leg, and to the top of the trolley, a stiffening member was attached. In raising and lowering the bucket leg, a parallelogram formed by the walking beam and leg brace, kept the leg in a vertical position. A hopper or larry supported by the main gantry received the ore for loading into cars.

Mr. Hulett's invention was so revolutionary that it was remarkable that he persuaded any one to buy the first machine. However, this he did with the Pittsburgh and Conneaut Dock Company in 1898. The first automatic stiff leg unloader was erected at their dock at Conneaut Harbor, Ohio. It was tested in 1899 and placed in regular service in 1900.

So sound was the engineering of this development that it has stood the test of time for a period of 45 years. The functioning of these machines has not changed over the years. Motive power was changed from steam-hydraulic to electric; details were redesigned, increases in speed and capacity have naturally resulted, but in all the years since its conception, no ore unloading mechanism has challenged its efficient and low cost unloading of large tonnages of ore.

Since the installation of the first machine at Conneaut in 1899, a total of about 66 Hulett unloaders have been built. The capacities of these machines have varied from 8, 10, 15, 17 to 20 tons of ore. One machine has a capacity of 8 tons of coal, another one of 20 cubic yards of garbage and rubbish. Of these, there are in operation today a total of approximately 40 machines thirty years or more old, and eight over 25 years old. This outstanding service life is the result of sound engineering and efficient operation at the docks. Large tonnages of coal and limestone are unloaded at steel plants, and in the past, cargoes of pig iron have also been unloaded. While the latter was probably emergency unloading, it is remarkable that pig iron can be picked up by a bucket at all.

Acknowledgment is made of the contributions of the leading manufacturers of electrical equipment, whose electrical control has been continuously improved and has played so important a part in the success of unloader operation. Some of the machines over thirty years old have their original controls. Naturally, many contactors and other parts have been replaced, but the original equipment is in the main still in use.

During the past two years outstanding improvements in Huletts have resulted from the cooperation of dock managements and engineers. The benefit of their experience and cooperation was of great value in the re-engineering of new 17-ton machines for Chicago and Cleveland and in the complete new engineering of 20-ton machines for Gary, Indiana, and Lorain, Ohio. The use of hardened tooth gears, alloy steels, anti-friction and swivel bearings, low alloy steel in highly stressed structural members, increased motor capacity and larger bucket scoops in the new machines, promise not only increased capacity, but longer life with minimum repairs.

The new machines recently fabricated for installation at the Lorain plant of the National Tube Company, are unique. This plant is located on a curve of the river and the dock is semicircular with a radius varying from 1259 to 1400 feet. The original unloading plant consisted of four Huletts of 10-ton capacity. These were in continuous operation since 1906. The front sills and trucks travel on a circular track of varying radius 5 ft larger than the dock. The rear sills and trucks operate on a concentric track giving a span of 57 ft. The rear tracks are elevated 8 ft 8 in. above the front ones. Naturally, in moving the unloaders from hatch to hatch on a circular track, the centerline of the unloaders can

**Figure 3 — The original Hulett ore unloader, with a capacity of 10 tons and steam-hydraulic operation, was placed in service in 1900.**

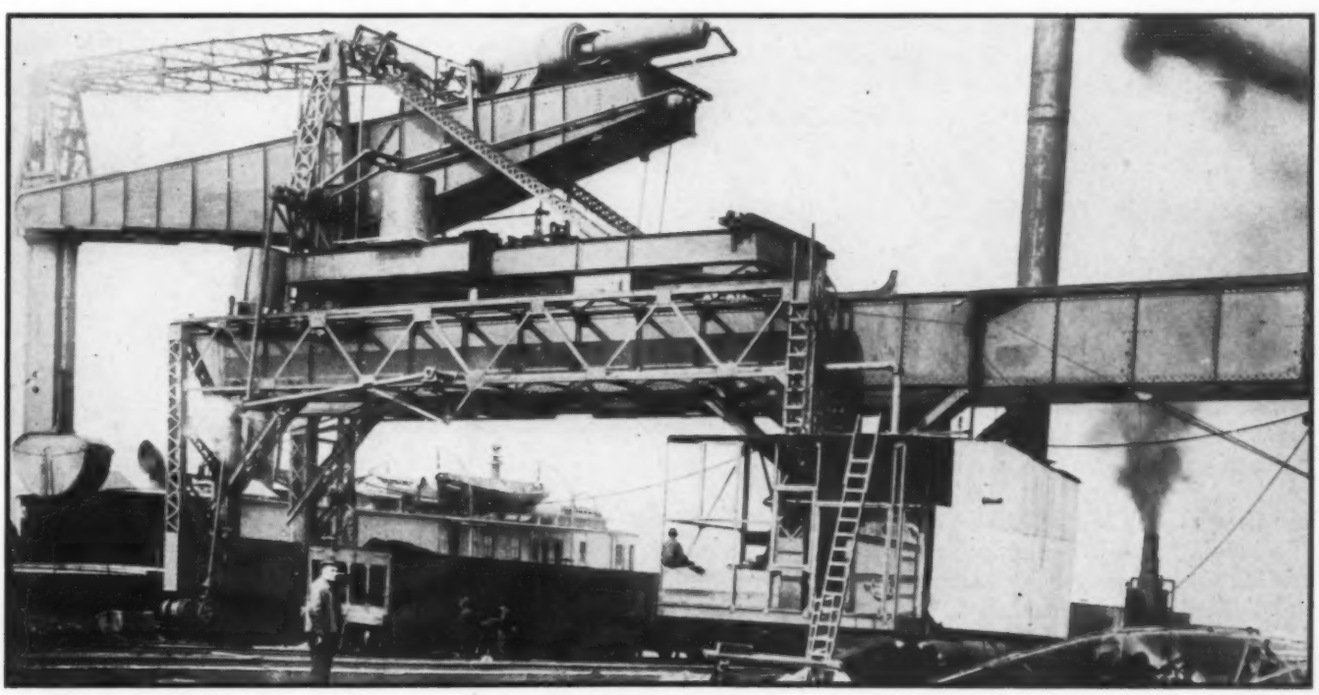


**Figure 4 — Five unloaders make this Pittsburgh and Conneaut Dock Company ore unloading dock at Conneaut, Ohio, the world's fastest.**

only coincide with one hatch of the boat. At all other hatches, it is necessary to swivel the unloader to line up with the hatch. This is accomplished in a unique and, we believe, a previously untried way on so large and heavy a structure. The rear sills are pivoted to the rear tower, the front sills and tower are connected through a large crank. To align the unloader at right angles to the ship, the front of the machine is swiveled on the crank. Instead of the conventional larry used to load ore into cars or into the receiving trough at the rear of the unloader, the ore is carried from the receiving hopper at the front of the machine, on a cross conveyor operating in both directions. This cross conveyor can be swiveled to load the ore into cars on either of two tracks and when reversed in direction will load the ore onto a flight conveyor, which carries it to the rear of the machine where it is dropped into the trough. The ore then is rehandled by a bridge onto the stock pile.

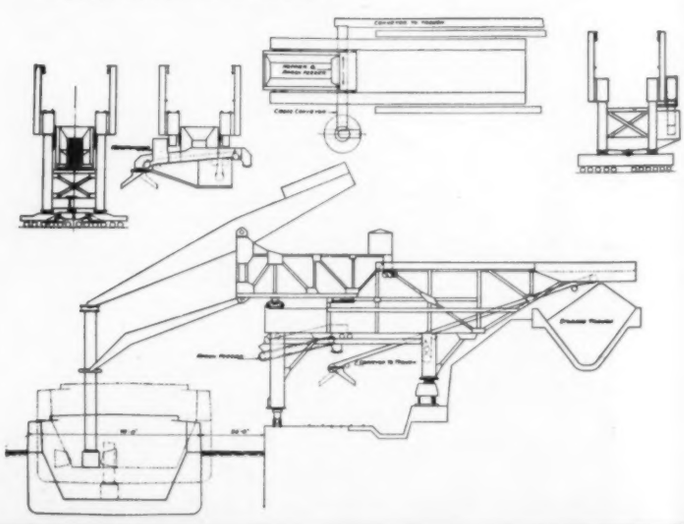
The new 20-ton Huletts at Gary and for Lorain were designed not only for the recently built 67 ft beam ore boats, but to unload future boats of 70 ft beam. When one of the new boats is docked at Lorain, there will be a span of 24 ft of water between the dock and the center of the ship. To span this distance and reach the outboard side of the ship, it was necessary to increase the walking beam reach from the normal 54 ft to 64 ft. The maximum reach of the bucket beyond the dock is 67 ft. The longer beam and leg brace greatly increased the weight, which is reflected in high wheel loads. This was taken care of by increasing the number of main travel trucks and by using double rails of wide face on the girders and double tread, universally equalized trucks on the trolley.

The question of why the latest design increased the rated capacity of the scoops only from 17 to 20 tons, or 17 per cent plus, may arise. Two conditions were responsible. First, there are in operation today many ore ships of old design and moderate tonnage, with narrow hatches. These boats will be in service for many years. Some of them have 8 ft hatches which limit the width of bucket scoops. There is a more or less definite relationship between width and depth of scoop, therefore the capacity of buckets is limited by the width of ship hatch. Second, most new machines are placed on existing docks, many of which are of considerable age and limited carrying capacity. Wheel loads are thus limited and the number of traveling wheels and trucks supporting an unloader are governed by the center to center distance of hatches. However, the increase of three tons rated capacity of bucket does not tell the whole story. Decreased operating cycle with larger capacity motors and higher speeds, shorter travel obtained by moving the receiving hopper forward and lower, fewer delays from breakdowns as a result of using better materials both mechanically and electrically will, we are sure, materially increase the overall average capacity per hour. Then, too, the increased reach of the new machines reduced the clean-up time, a particularly troublesome matter now, due to the shortage of labor.

In 1942, the peak year of ore shipments, a total of 92,076,781 tons was brought down the Lakes. In 1943, due to the lateness of the season's opening and bad weather at the end of the year 84,404,852 tons were hauled.

The docks at Conneaut, Ohio have the reputation of being the fastest and most efficient on the Lakes. Their record of ore unloaded per machine-hour exceeds that of any other plant. As representative, the record of one lower lake dock with four machines over thirty years old, is interesting. In the 32 years of its existence, this

**Figure 5 — Modern 20-ton unloader designed to travel on curved tracks. Ore is deposited in a hopper and carried on conveyors to cars on tracks below or to storage trough at rear of unloader.**



dock has unloaded 120,834,647 gross tons of ore. This amounts to 944,000 gross tons per year per machine. The all-time record of this plant was made on November 16, 1943 in unloading the S. S. Col. J. Pickands with 11,680 vessel bill of lading gross tons in three hours and fifteen minutes, or an average of 898.5 gross tons per hour per machine, and a dock average for the four machines of 3594 tons per hour.

During the past season this dock unloaded four of the new 67 ft beam boats at tonnages varying from 760 gross tons per hour to 825 gross tons per hour per machine. This is a remarkable record for machines having insufficient span to completely reach the outside of the ships. These hourly rates compare favorably with those obtained in unloading 58 and 60 ft beam boats on which high records of slightly under 887 gross tons per hour per machine were made. The thirty-odd years' experience of this dock is interesting:

| | Average gross tons per machine hour |
|---|---|
| 1912 | 325 |
| 1916 | 438 |
| 1917 | 441 |
| 1929 | 520 |
| 1930 | 556 |
| 1931 | 610 |
| 1943 | 637 |

For any heavy equipment to better its record almost continuously year after year for 32 years is almost beyond belief and especially so for machines subject to such tremendous loads. Credit for this goes mainly to the dock management whose experience and resourcefulness have made this possible.

Referring to the above tabulation, the increasing record up to 1930 resulted solely from the efforts of management and from efficient operators. In 1930, the electric current furnished the machines was increased in voltage, making possible faster speed and an increase in tonnage per hour per machine of 36 tons, or say two additional cycles of operation per hour.

In 1931 the receiving hopper was lowered one foot and brought forward 12 ft. This increased the hourly average another 54 tons per hour. The docks' record in 1943 of 637 tons per hour was another increase of 27 tons over that of 1931. There was no change in equipment or operation to account for this increase. Little lost time due to breakdowns, continued excellent management and some advantage from larger average cargoes (9189 gross tons per ship in 1942, and 9998 gross tons per ship in 1943) all played a part in establishing the record.

**Figure 6 — Old type ore unloaders as used around the turn of the century.**

It is interesting to note the record of interruptions to operations in a season. Take the same dock and the peak year 1942. This is the year's record in unloading 1081 ships:

Time lost per machine per ship:

| | Minutes |
|---|---|
| Railway delays | .05 |
| Mechanical repairs | 2.67 |
| Electrical repairs | .52 |
| Shunter (car haulage) delays | None |
| Miscellaneous | 1.85 |
| Total | 5.09 |

The splendid service of the railroad industry is shown in this record. In a war year of great demands the average ship was delayed but five hundredths of a minute per machine, or a total of .2 minutes for lack of cars. This is truly remarkable.

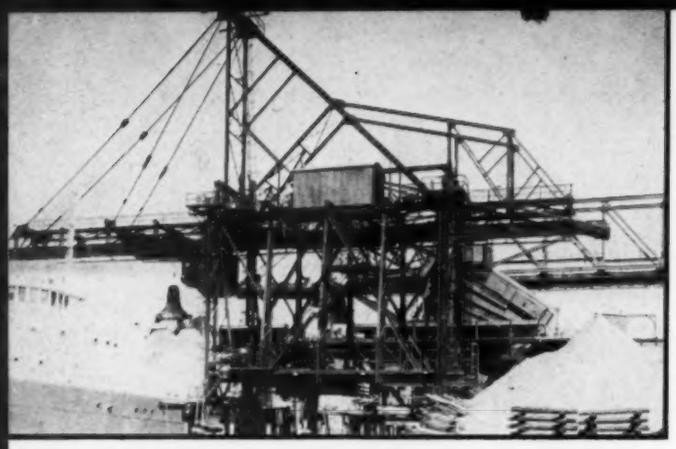
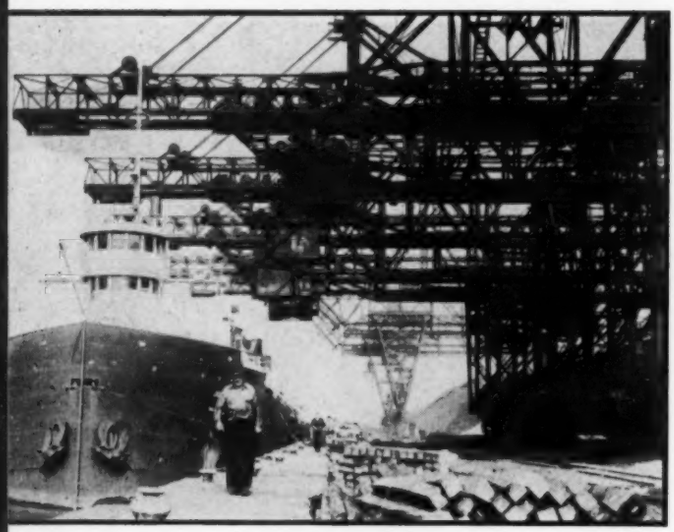


**Figure 7 — Ten-ton Brown-Hoist unloader in foreground. Two 10-ton Hulett unloaders are immediately back of it.**

▲

**Figure 8 — Unloading dock which is served only by 15-ton unloading-stocking bridges.**



Perhaps no other industrial equipment is given more attention in the off-season than ore unloaders. This contributes greatly to their service record.

The crew of each Hulett unloader consists of the following persons:

An operator who controls the opening, closing and revolving of the bucket, lowering into and hoisting out of the ship and traveling of the trolley for dumping the ore into the receiving hopper.

A larry man who rotates the hopper to discharge the ore into the larry, weighs the ore, travels the larry to dump the ore into cars or the receiving trough at the rear of the machine.

There is an oiler for each machine, four shovelers for cleaning up the hull of the ship, one laborer for clearing up the spilled ore on the deck, and a water-boy. Three mechanics and two electricians service the four machines. Four locomotives or shunters spot cars, with one operator on each. The above crew works 11½ hours and there are two turns per day.

There are in use on the Great Lakes a considerable number of bridge type unloaders, used in some instances because the quantity of ore handled is small and in others, notably Inland Steel Company at Indiana Harbor, because of preference. At the latter plant, modern clam-shell buckets rated at fifteen tons but actually of larger capacity are in use and the record of the dock is very good. There are other situations where the dock layout will not permit installation of such wide span machines as Hulett unloaders, notably the South Chicago docks.

Generally, the choice of equipment is predicated on tonnage to be handled, cost of unloading, and capital investment. Bridge type unloaders are much the cheaper type of equipment. The main difficulty with bridge type unloaders with rope-operated clam-shell buckets lies in the difficulty of keeping the bucket from turning when being raised or lowered through the hatch. When a clam-shell bucket picks up its load of ore, it is generally necessary to raise it off the cargo and let it come to rest in the hold of the ship before hoisting. This naturally consumes time and offsets the higher traveling speed over stiff-leg unloaders.

The main advance in late years in bridge type unloaders has been in the design and construction of buckets. The new low alloy steels of 45,000 to 60,000 psi yield and 70,000 to 90,000 psi ultimate strength have played an important part in their development. These materials, fabricated by welding with thermal stress relief, have made possible the building of buckets with long life, exceedingly low upkeep cost and low weight per ton of ore handled. We have records of ore buckets handling many millions of tons of ore without repairs except to move the manganese trays nearer together after wear.

In the field of ore rehandling, newly designed bridges have come to the fore in plants of two of America's largest steel mills. In addition to the heavy wide flange construction of the bridge structure, the main trolleys are supported by ten 33 in. diameter wheels with four of the five axles individually motor and worm driven. The hold and hoist mechanisms are placed on a substructure suspended from the trolley and are likewise worm driven, as are the main travel wheels. Wheel loads are kept to a minimum by using 16 wheels under each corner of the bridge. This new type of bridge with 20-ton capacity welded clam-shell buckets, while high in first cost, promises low operating and up-keep expense, which justifies its selection.

The loading of coal into ships at the lower lake docks has a background very similar to the unloading of ore boats. The boat shipment of coal up the lakes dates back to 1850. The first cargo came to Cleveland from the Mahoning Valley in canal boats, was unloaded by hand into wheelbarrows and stored on the dock, whence it was rehandled into wheelbarrows and dumped into the hatch of the boat. This was the reversal of the earliest operation of unloading ore from ships at lower lake docks. The development of coal handling progressed to the use of whirleys with one ton tubs, in use from 1875 to 1885. By 1892 the size of the tubs was increased to five tons. In 1890 the first car dumper was installed on the Cleveland, Canton and Southern Railway docks at Cleveland for handling coal cars of ten to twenty tons' capacity.

The first lifting car dumper was installed in 1896 and was highly successful. The operation of lifting car dumpers consists of pushing a loaded car onto a cradle, where it is clamped to the rails by means of heavy clamps which press against the top of the car, holding it onto the rails of the cradle. The cradle is elevated and then inverted so that the coal runs out of the car onto

a pan from which it flows by gravity into a chute which directs the coal into the hold of the ship. After dumping the coal from the car, the cradle is brought back to its vertical position and lowered to the starting point. The coal car is then bumped out of the cradle by the next incoming loaded car and the empty car runs down the discharge track into the empty storage yard.

The modern high lift car dumper follows closely the original design. Originally, they were steam machines and many of these are still in operation. The first electrically operated dumper was installed at Baltimore in 1921 at the Western Maryland Railway Company. In 1926 the first electrically operated high lift dumper on the lakes was installed at Toledo, Ohio, for the Ohio Central Railway Company. The cradle and mulecar motions employ Ward-Leonard control and the cradle is over counter-balanced so that the power required to raise the loaded car is approximately the same as to lower the empty one. The Toledo dumper and those following were designed to handle 120 ton cars at the rate of 40 per hour. These cars weigh 160 tons when loaded, and about 40 tons light. The energy used per ton of coal in 70-ton cars after installation of the dumper was only .24 kw-hr.

To lessen the degradation of coal in dumping, the flow of coal from the car is now retarded by lowering a series of plate covers onto the top of the car, thus preventing the catapulting of lumps of coal onto the platen during dumping. As the cradle revolves, the hinged covers slowly swing forward, permitting the coal to flow onto the pan. The pan and telescopic chute for directing the coal into the ship's hold, are not allowed to become completely empty. This, too, retards the flow and prevents degradation. Laying of coal dust and

**Figure 9 — High-lift car dumper, 120-ton capacity, of the type in use on lower lake docks.**

**Figure 10 — Traveling turn-over dumper as used for storage of material where some elevation of car is required.**

obtaining a predetermined moisture content is achieved by spraying on water as the coal leaves the car.

Other types of car dumpers have won wide acceptance where ore and coal of considerable tonnage is used industrially. These are the revolving and the turn-over dumpers. The former is simply a rotating cylinder having a platen with rails which align with the railroad track. The car is pushed onto the platen. As the cylindrical dumper revolved on supporting rollers, automatic counterweight operated clamps are pressed against the top of the car holding the latter to the rails. As the dumper revolves, the material runs out of the car, generally into a hopper from which it is carried by conveyors to the desired location.

The turn-over dumper is similar to the high lift dumper except that the cradle is not elevated but rotated around a fixed pivot. This type of dumper provides higher elevation of the car when dumping than with a revolving dumper, but less elevation than with a high lift dumper. The turn-over dumper is naturally more costly than the revolving type, but the cost of both is much smaller than the high lift machine. Turnover dumpers are built of the traveling type as well as stationary. The traveling dumper is used mainly where the material is to be spread along a storage pile.

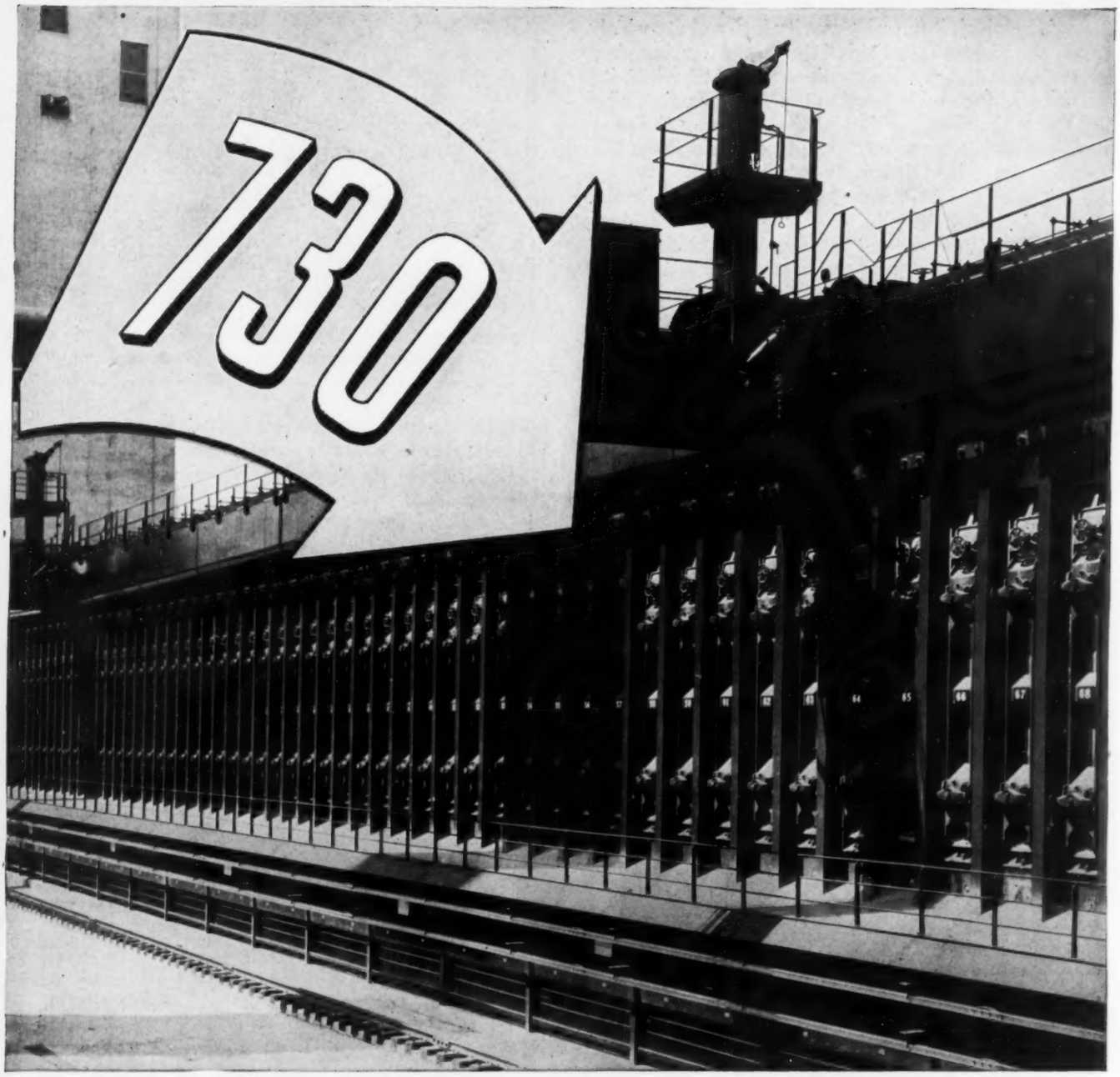
Of the 46 million and 47 million tons of coal handled at Lake Erie ports in 1943 and 1942, the Toledo tonnage far exceeds that of any other port. In fact, Toledo's tonnage in the peak year of 1942 was nearly 50 per cent of that handled by all ports.

The record of the Chesapeake and Ohio Railway dock at Toledo is interesting. This dock consists of three lifting dumpers. In 1942 a total of 15,654,717 net tons of coal was put through the three dumpers. In 1943 the tonnage was 14,858,101. The following records of operation are given:

| | | |
|---|---|---|
| **Day record, April 29, 1942** | **1,957 cars,** | **114,333 tons** |
| **Month record, October, 1943** | **37,667 cars,** | **2,180,492 tons** |
| **Year record, 1942** | **265,231 cars,** | **15,654,717 tons** |

This means that on April 29, 1942, one car was dumped every 44 seconds during the 24-hour period, and in October, 1943, one car was dumped every 71 seconds.

Unloading ore boats and loading coal in ships has reached a high degree of efficiency. Future developments and refinements to present methods of equipment will probably not greatly increase production. However, future developments may some day revolutionize present methods of handling ore and coal.

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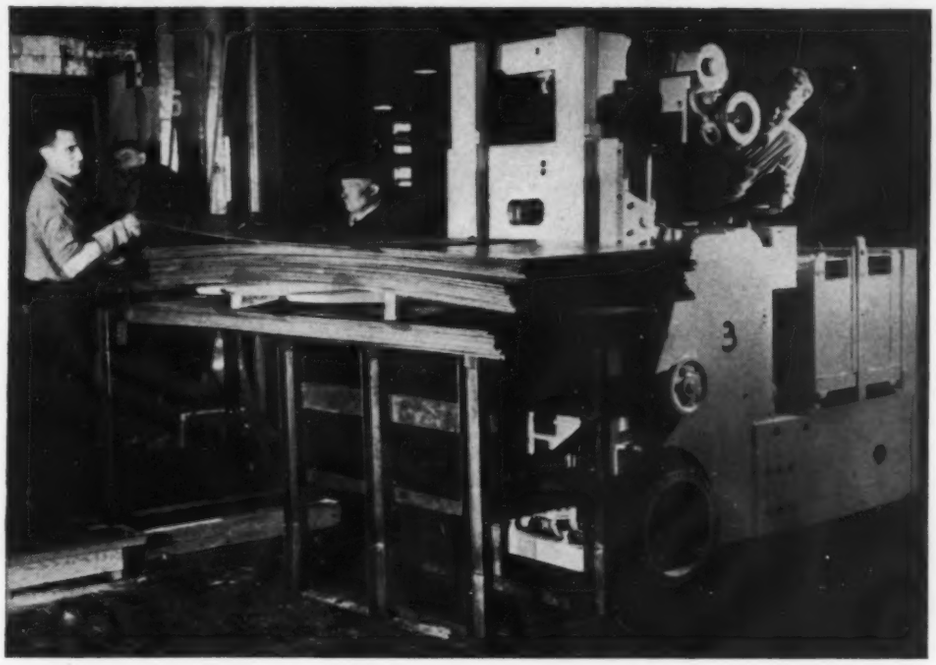

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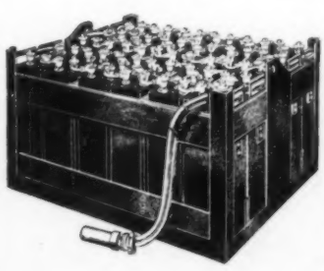
With batteries exchanged two or three times a day, the truck is kept continuously supplied with power. While one battery is being charged, another operates the truck.

The truck starts instantly, accelerates smoothly; operates quietly; gives off no fumes; consumes no power during stops. Thus, it makes efficient use of power, and the current used for charging its batteries is the lowest-cost power available. Its electric-motor drives have a minimum of wearing parts and are inherently simple and trouble-free.

A battery industrial truck is most dependable and most economical when powered by Edison Alkaline Batteries. With steel cell construction, a solution that is a natural preservative of steel, and a fool-proof principle of operation, they are the most durable, longest lived, and most trouble-free of all types of batteries. *Edison Storage Battery Division of Thomas A. Edison, Inc., West Orange, N. J.*



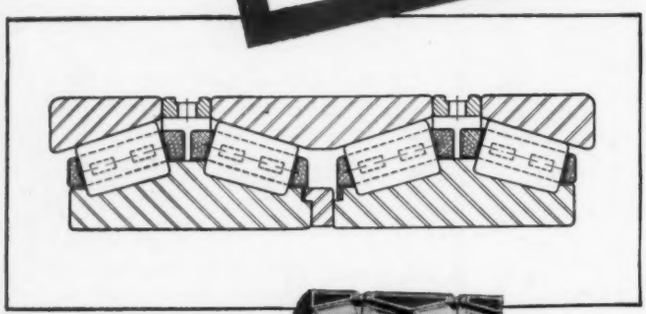
***In Industrial Trucks, Alkaline Batteries Give You These Important Advantages***

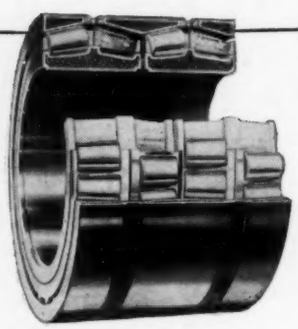
- They are **durable mechanically;** grids, containers and other structural parts of the cells are of steel; the alkaline electrolyte is a preservative of steel.
- They can be **charged rapidly;** gassing cannot dislodge the active materials.
- They **withstand temperature extremes;** are free from freezing hazard; are easily ventilated for rapid cooling.
- They are **foolproof electrically;** are not injured by short circuiting, reverse charging or similar accidents.
- They can **stand idle indefinitely** without injury. Merely discharge, short-circuit, and store in a clean, dry place.
- They are **simple and easy to maintain.**

Edison
ALKALINE BATTERIES

# CHROME NICKEL STEEL

## FOR ALL-OUT ROLL NECK BEARING PERFORMANCE





*Cross section and cutaway view of the 21.500" O. D. 4-row tapered roller bearing used on the working rolls of a 3-high mill. Radial capacity at 100 r.p.m. is 550,000 pounds; thrust capacity 168,000 pounds.*

Helping rolling mills achieve peak tonnages is the year-round job of Torrington four-row tapered roller bearings on roll necks. Built of S.A.E.-E3310 steel (with higher nickel content) for maximum tonnage and service life, these sturdy Torrington Bearings efficiently minimize friction . . . handle maximum loads with minimum maintenance requirements . . . are easily lubricated and serviced.

That's typical Torrington Bearing performance. And it's why you find Torrington Bearings of many types and sizes widely used in the steel industry . . . on back-up rolls and work-rolls . . . screw downs, vertical edger rolls, table rolls, sheet levelers and shears . . . in drives and pinion stands . . . on many other machines where they carry heavy loads at low maintenance cost.

The engineers of Torrington's Bantam Bearings Division specialize in meeting heavy-duty, high-speed, anti-friction requirements, routine or unusual. Their advice and cooperation is at your disposal.

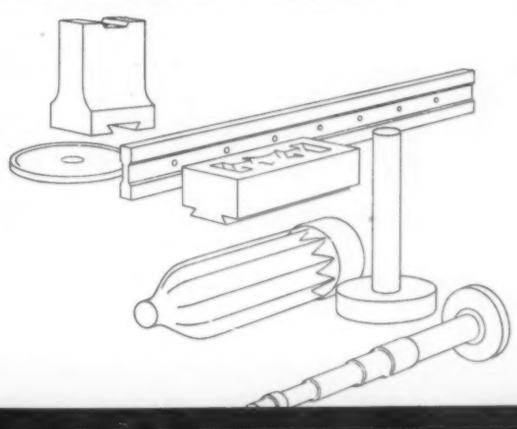
**THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION**
**SOUTH BEND 21, INDIANA**

# TORRINGTON BEARINGS

**STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL**

# **Heppenstall:** the most dependable name in forgings

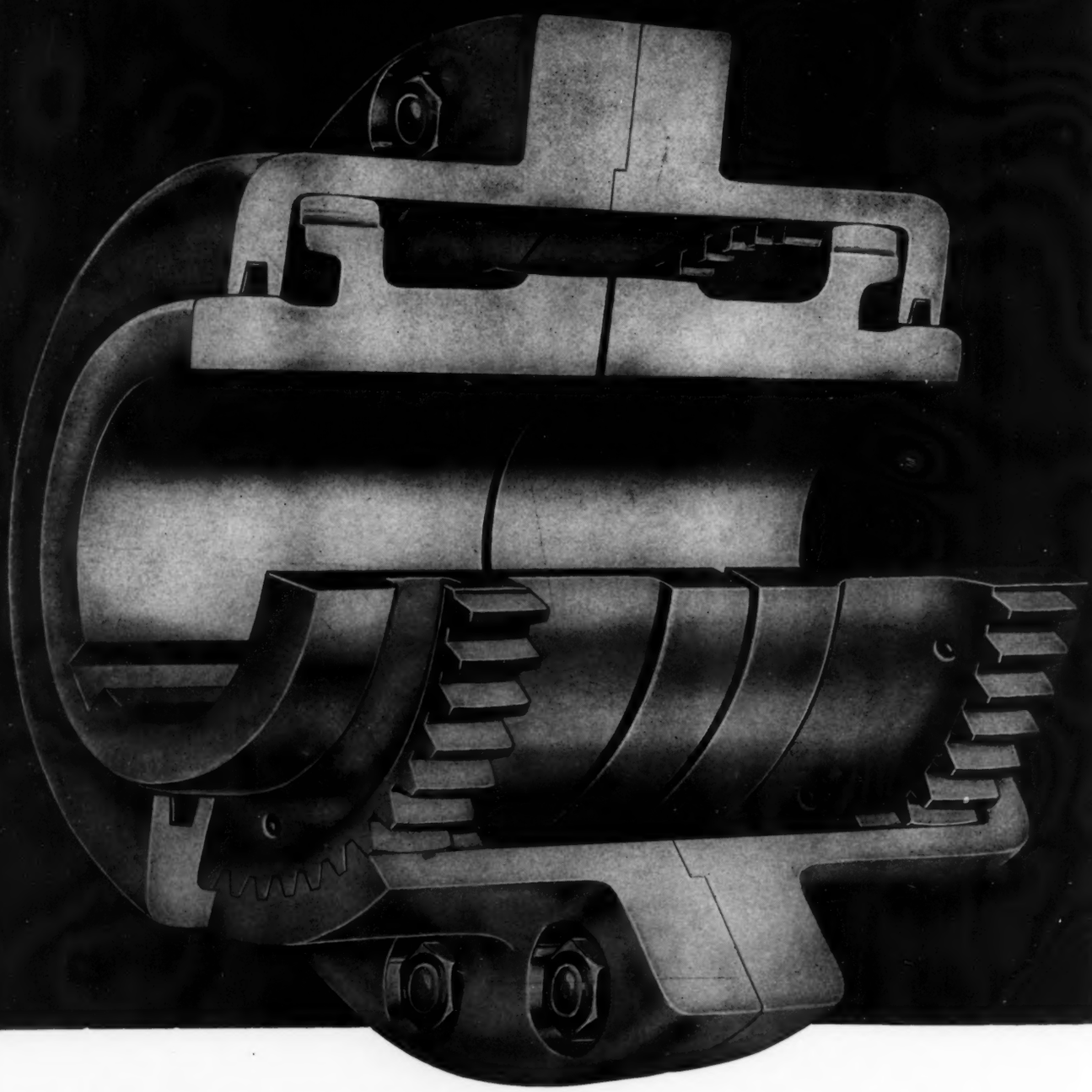
*In charting your course of future business, it's well to remember that Heppenstall Forgings have a time-proved record for extra service . . . Dollar for dollar they'll cost you less to use—Heppenstall* guarantees *it . . . Heppenstall Co., Pittsburgh, Pa.*



Your personal war effort is important!

**PUSH PRODUCTION • PUSH BOND SALES**

# POOLE



COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

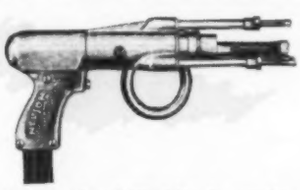
# FLEXIBLE COUPLINGS

DOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

# Stud welded in 1/2 second to Open-Hearth Door!

**To increase the life** of open-hearth doors—to cut repair time—steel manufacturers are now using this *automatic* means of end-welding studs to metal. The studs are rapidly installed by a welding gun, and their complete fusion to the metal door is increasing door life as much as 150 heats or more without restudding.

The stud is inserted in the Nelson Stud Welder and the trigger pulled. Instantly the stud lifts, allowing the hot welding arc to fly from the end of the stud to the door. The stud is then automatically plunged into the molten metal and is fused to the door. These Nelson stud welds are as strong as any hand method. Welds are consistent with full fillet.



The Nelson Stud Welder is used with a standard generator and an automatic timer control unit which regulates the time the welding current flows. Consistent welds are assured.

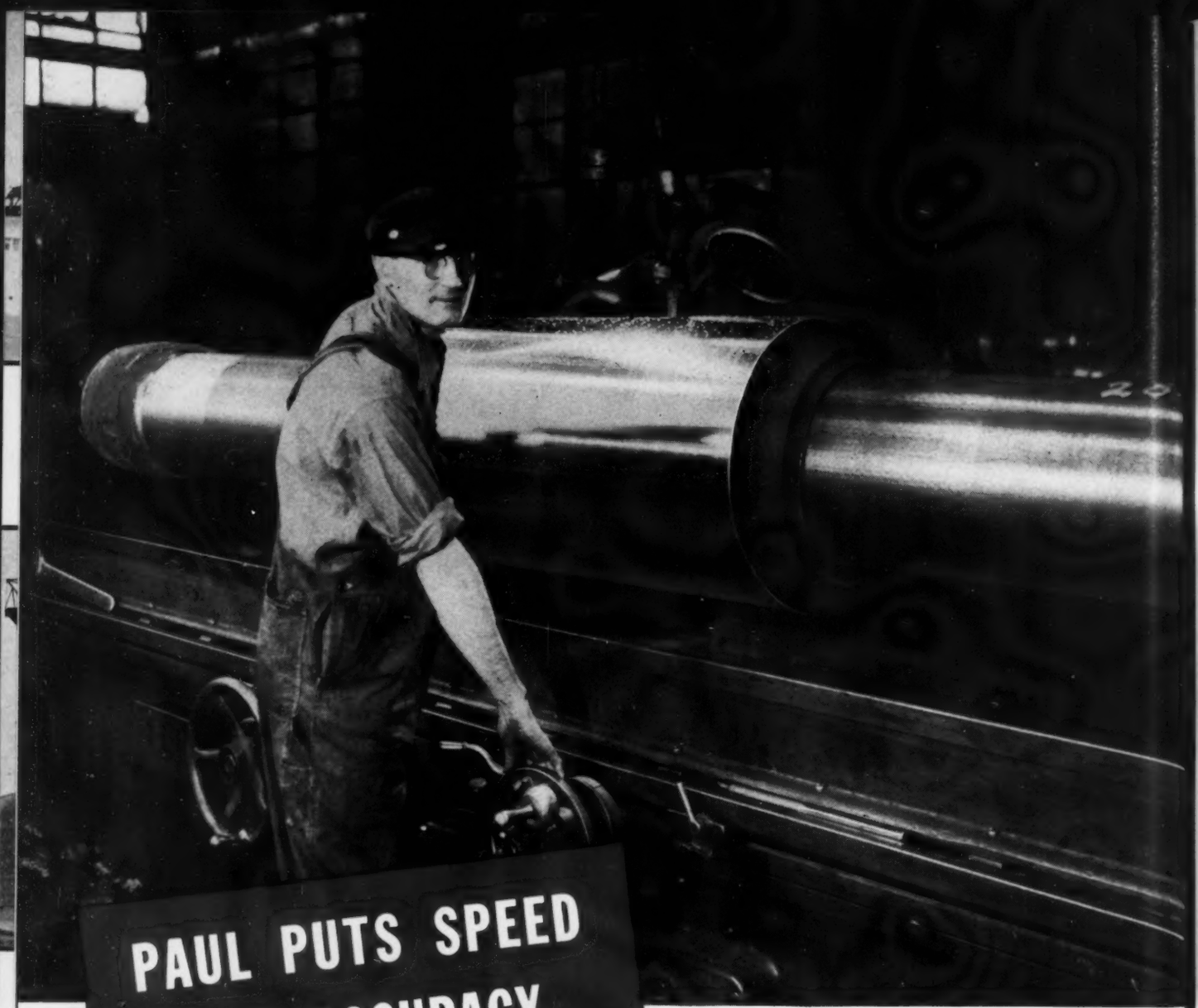
No previous welding experience is necessary. Operators are welding as many as 500 to 1000 studs per shift.

Now thousands of stud welders are being used in more than 650 industrial plants and shipyards. ***Write for complete information, catalog, and report "Stud Welding Open-Hearth Doors":***

**NELSON SPECIALTY WELDING EQUIPMENT CORP.**
**Dept. 10, 440 Peralta Avenue**
**San Leandro, Calif.**

*Eastern Rep.: Camden Stud Welding Corp. Dept. 122, 1416 So. Sixth St., Camden, N. J.*

**NELSON STUD WELDING**



# PAUL PUTS SPEED AND ACCURACY INTO YOUR PRODUCTION

Like most of the top-notch machinists here, Paul Applegarth served his apprenticeship in the Lewis shops. His eighteen years experience in this specialized profession qualifies him as a past master at roll grinding . . . Just one of the factors responsible for the quality and reputation of Lewis Rolls.

Paul's second interest is the letters from his son, Don, now with the Army Air Corps in India.

ARMY E NAVY

6 plants of Blaw-Knox Company have been awarded the Army-Navy "E" for excellence

**LEWIS FOUNDRY & MACHINE . . . Division of BLAW-KNOX Company, Pittsburgh, Pa.**

# LEWIS ROLLS

# SELF CONTAINED 2300 VOLT OIL IMMERSED A.C. INDUCTION MOTOR CONTROL

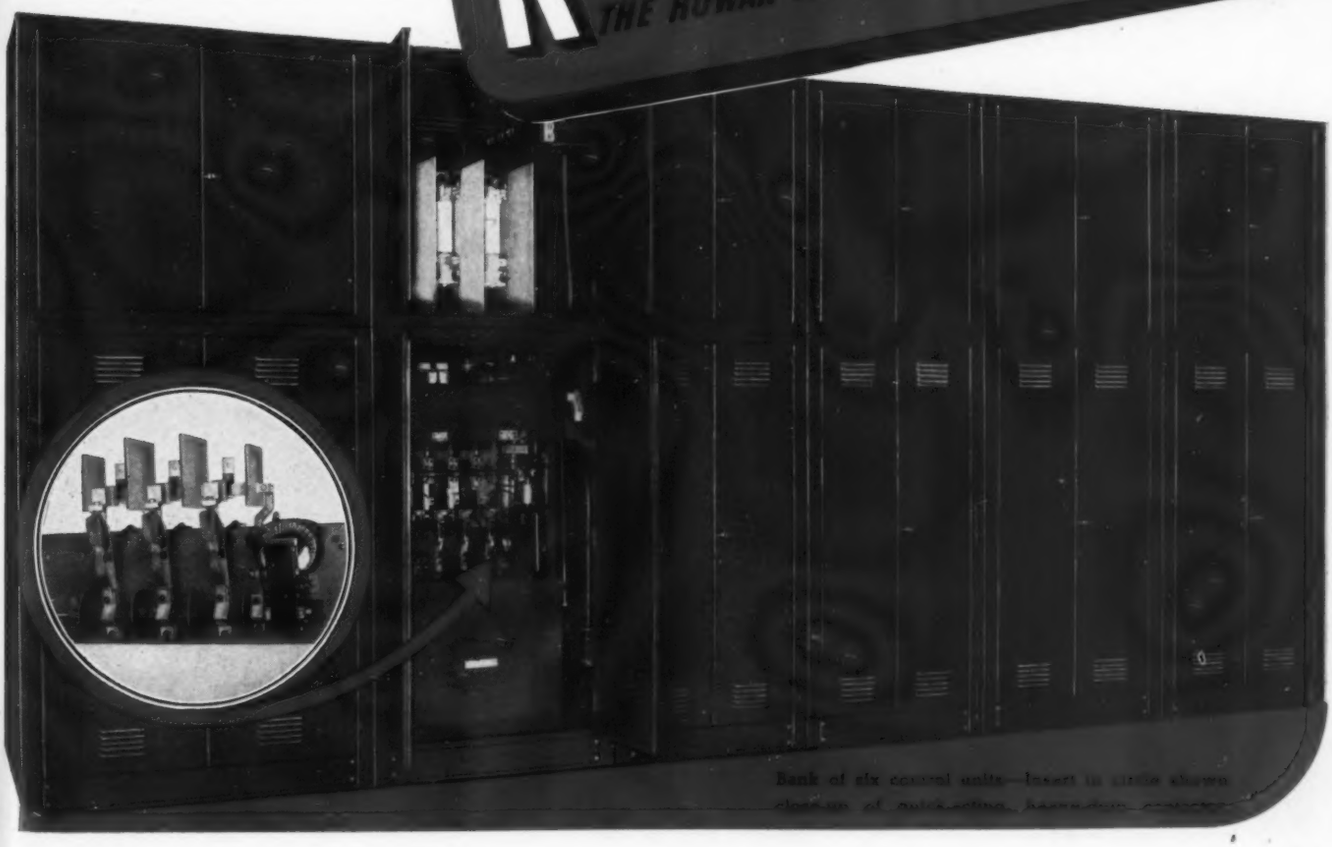
**CONSTRUCTION AND OPERATING FEATURES**

1. They have an especially designed, quick-acting, heavy-duty contactor.
2. High interrupting disconnect fuses, hook stick operated.
3. Self-contained, seal-off motor terminal compartment.
4. Centralized self-contained low voltage control terminal compartment.
5. Magnetic overload relays with electric reset, instantaneous and inverse time element.
6. Self-contained control potential transformer.
7. Self-contained Tank lowering device.
8. Insulated Bus, supported on porcelain Insulators.

The simplicity, efficiency, and flexibility of this Push Button operated Control have been made possible by Rowan Engineers after thirteen years of research, and production of this type of equipment. It has been designed for Engineers whose prime thoughts are safety, continuous operation, minimum installation and maintenance cost. These starters are floor mounted and are arranged for single or group installation. They are Push Button operated; of the full voltage or reduced voltage type; arranged for indoor, or outdoor service; are of cubicle construction and are complete within themselves. *Let us have your 2300 Volt control problems.*

# ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



Bank of six control units—Insert in circle shows close-up of auto-acting, harmless contacts

# "3C" TAKES ON A NEW MEANING . . .
# CAPACITY-CAPABILITY-CONTINUITY

*(No. 1 of a series of Advertisements)*

## CAPACITY

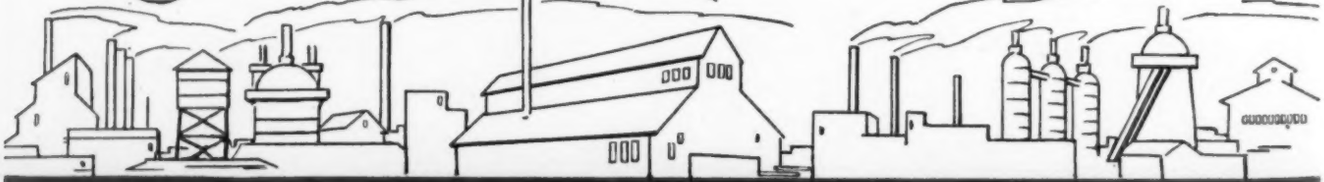
The newly expanded Clark Controller Company plant appears as shown in the above picture. Approximately three acres under one roof permits combining personnel and equipment from our other plants in one central location.

Additional machinery and equipment being installed will facilitate production of all types of "3C" Electrical Control apparatus.

This new CAPACITY means more to us than mere added space. It means a co-ordinated capacity to:

1. **Develop new apparatus**
2. **Improve existing devices**
3. **Increase Commercial and Application Engineering Service**
4. **Utilize in general our trained, experienced personnel to give maximum service to users of "3C" Control**

That is what we mean by CAPACITY.



**THE CLARK CONTROLLER CO.**

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL

*Number 9 of a Series:* **"Looking at the 5 essential things you never see in electrodes!"**

*Arc-lit Brooklyn Bridge . . . before the turn of the Century*

# The Light That Has Never Gone Out!

THE CARBON-ARC STREET LAMP cast its brilliant light long and efficiently over America's great bridges and thoroughfares. Then the arc blazed ahead to become one of industry's most useful tools.

But the light from the old street lamp still shines in the lesson it taught us about selecting exactly the right raw materials for making its "carbons"—forerunners of today's huge carbon and graphite electric-furnace electrodes.

Utmost care in selecting raw materials precedes the manufacture of all "National" carbon and "Acheson" graphite furnace electrodes . . . electrodes that are strongly shock resistant, uniform in size, of high electrical conductivity, and that are consumed slowly.

Raw materials selection, however, is just one of *five* essential things you *never see* in electrodes. The others are manufacturing experience, manufacturing control, continuing research and customer service. You should insist on them all in electrodes. We welcome inquiries.

NATIONAL CARBON — ACHESON GRAPHITE

The words "National" and "Acheson" and the "National" and "Acheson" Seals are registered trade-marks of National Carbon Company, Inc.

***KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!***

**NATIONAL CARBON COMPANY, INC.**
*Unit of Union Carbide and Carbon Corporation*
UCC
*GENERAL OFFICES: 30 East 42nd Street, New York 17, N.Y.*
*DIVISION SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco*
*In Canada: Canadian National Carbon Company Limited, Welland, Ontario*

# for "HERE-TO-STAY" Welding Jobs

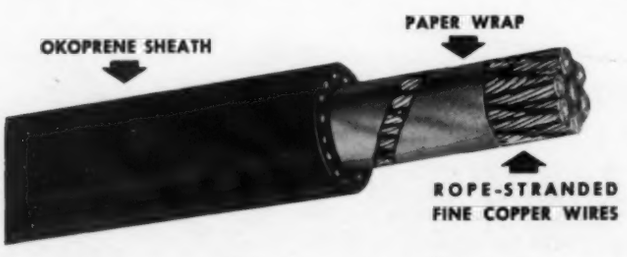
# ...OKOCORD flexible cables

FOR the many welding jobs in plant repair departments . . . for those among the wartime welding operations which will not revert to riveting in steel fabricating shops after victory . . . delivery of electrical power can be entrusted safely to Okocord Portable Cables.

Okocord cables for welding are designed to transmit uninterrupted power under severe conditions and external abuse. In the Okocord single conductor electrode-holder cable shown here, fine copper wires are rope-stranded for greater flexibility. They give longer life because they are first stranded together on the Uni-lay* principle and then "lubricated" by Okonite's special treatment. Their increased flexibility results in better welding through easier, less tiring use of the electrode-holder. A paper wrap over the conductor leaves it clean for terminating, increasing flexibility still further. Additional mechanical strength is provided by seine twine cords embedded in an Okoprene sheath while the Okoprene protects against corrosion, resists oil, acids and alkalies.

Talk over your special needs with an engineer of The Okonite Company, Passaic, New Jersey.

**Method developed under wartime secrecy for the U. S. Navy.*




**OKOCORD ELECTRODE-HOLDER CABLE**

| Size A.W.G. | Number of Wires | Carrying Capacity Amperes | Volts drop 60° C. Copper Temp. |
|---|---|---|---|
| 4 | 1078 | 100 | 3.18 per 100 ft. |
| 3 | 1372 | 150 | 3.70 " " " |
| 2 | 1715 | 200 | 3.92 " " " |
| 1 | 2156 | 250 | 3.88 " " " |
| 1/0 | 2695 | 300 | 3.72 " " " |
| 2/0 | 3381 | 375 | 3.68 " " " |
| 3/0 | 4263 | 450 | 3.51 " " " |
| 4/0 | 5341 | 550 | 3.41 " " " |

ARMY-E NAVY

**OKONITE** OKONITE SINCE 1878

**insulated wires and cables**

4077

The exacting and critical technique of making steel allows no tolerance for men, methods, or machines that cannot do their part under high pressure production schedules . . . day after day and year after year.

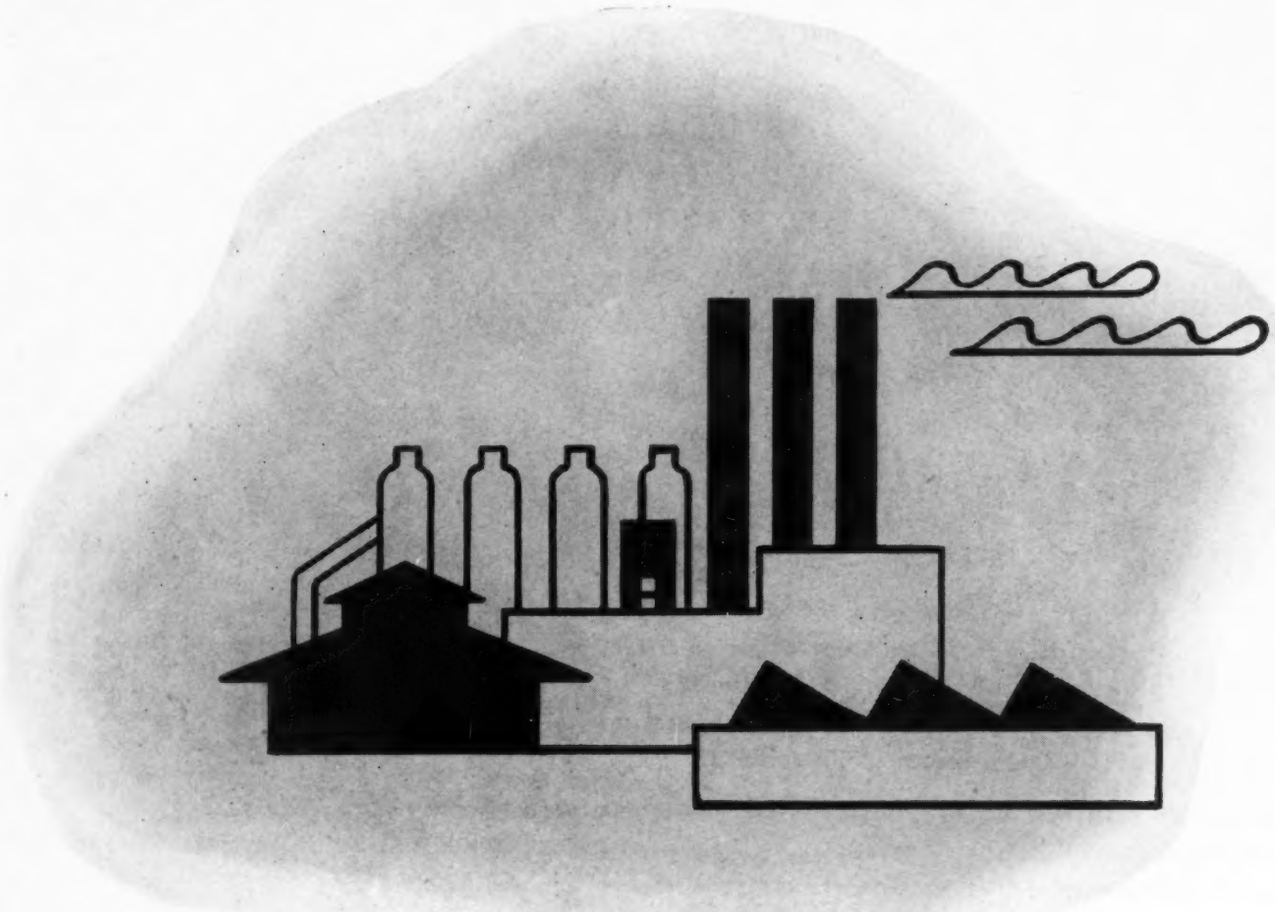
It is, therefore, significant that in the field of Control Equipment, Askania Automatic Control has achieved the position of Leadership amongst the Leaders in the Steel Industry. The list of users below is testimony to the fact that Askania makes good its claim . . . "more steel . . . better steel . . . at lower cost."

**Allegheny Ludlum Steel Corporation**
**American Rolling Mill Company**
**American Steel and Wire Company**
**Bethlehem Steel Company**
**A. M. Byers Company**
**Carnegie Illinois Steel Corporation**
**Colorado Fuel and Iron Corporation**
**Columbia Steel Company**
**Crucible Steel Company of America**
**Ford Motor Company**
**Geneva Steel Company**
**Great Lakes Steel Corporation**
**Inland Steel Company**
**International Harvester Company**
**Jones & Laughlin Steel Corporation**
**Kaiser Company, Inc.**
**The Midvale Company**
**National Tube Company**
**Pittsburgh Steel Company**
**Republic Steel Corporation**
**Sheffield Steel Corporation**
**Tennessee Coal, Iron and Railroad Company**
**The Timken Roller Bearing Company**
**Weirton Steel Company**
**Wheeling Steel Corporation**
**Youngstown Sheet and Tube Company**

**ASKANIA REGULATOR CO.**
A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY
1601 S. MICHIGAN AVENUE, CHICAGO 16, ILLINOIS

# *Modernize Your Mill*

# WITH G-E TEXTOLITE ROLL-NECK BEARINGS



**NOW IS THE TIME** *for steel men to take a look into the future; competition will be keen with emphasis on rapid, economical production.*

*To increase tonnage, lower operating costs and improve operating conditions, equip your mill with G-E Textolite roll-neck bearings.*

*The General Electric Company places its staff of experienced engineers and fifteen years of accumulated bearing engineering data at your disposal. Your conversion problems are welcomed by us. For further information write to Section W-69, General Electric Company, One Plastics Avenue, Pittsfield, Mass.*

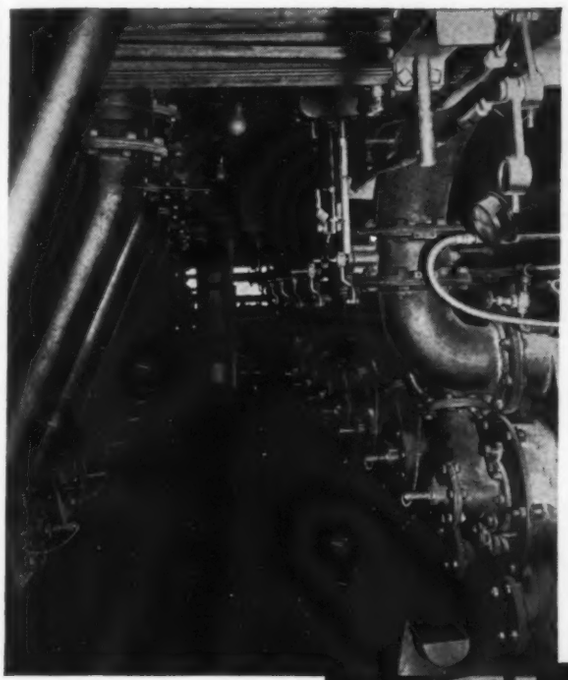
**GENERAL ELECTRIC**

PD-69

**BUY WAR BONDS**

Hear the General Electric radio programs: "The G-E All-Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

# SIMPLIFIED FIRING FOR METALLURGICAL FURNACES . . .



## SAVES FUEL AND SPACE INCREASES PRODUCTION

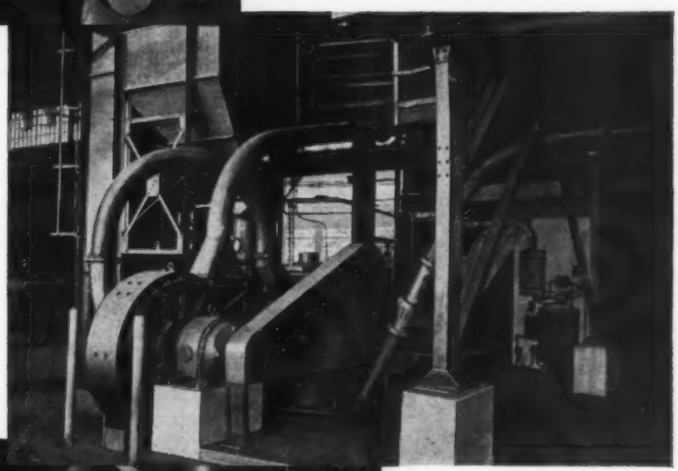
Dependable and economical pulverized-coal firing of multiple metallurgical furnaces requires only ONE pulverizing unit with the B&W Direct-Firing Circulating System. Thus, many substantial savings on installation, production, and maintenance over other methods of firing are obtained.

Simplicity of the system eliminates multiple piping and coal handling equipment, saves floor space around the furnaces, and eliminates interference with product handling at the furnaces.

Adequate fuel distribution and capacity of this system on single or multiple furnaces is assured by automatic control of coal-to-air ratio, by selection of the proper sizes of pulverizers, fan, burners, and distributing line.

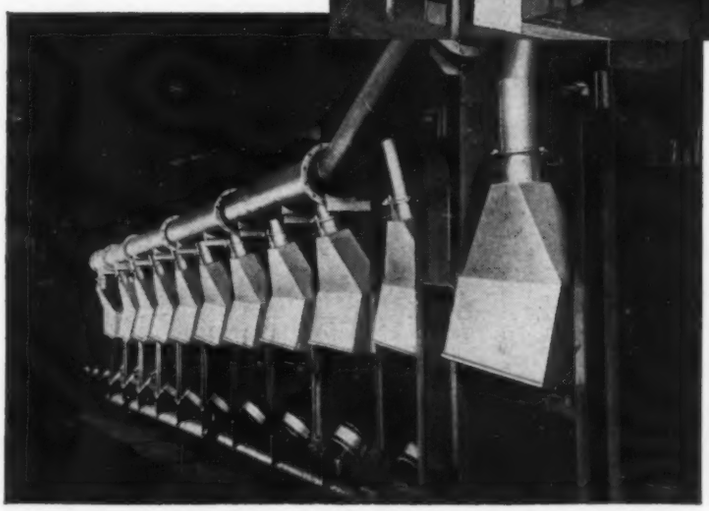
The operating ease and flexibility of this system, as well as its cost-saving features, have been clearly demonstrated by the performance of existing installations.

A few of the advantages of the B&W Direct-Firing Circulating System are illustrated here. More detailed information is contained in Bulletin 3-333. Send for your copy.



**1** Multiple burner installation on single large furnace of double heating zone type. Burners at right firing heating zone and first group of burners in the circuit. Burners at left fire soaking zone and last group in the same circuit, which also serves a second large furnace of the double heating zone type.

**2** The single, compact pulverizer unit can be conveniently located away from the furnaces, keeping floor space at furnaces clear for product-handling operations.

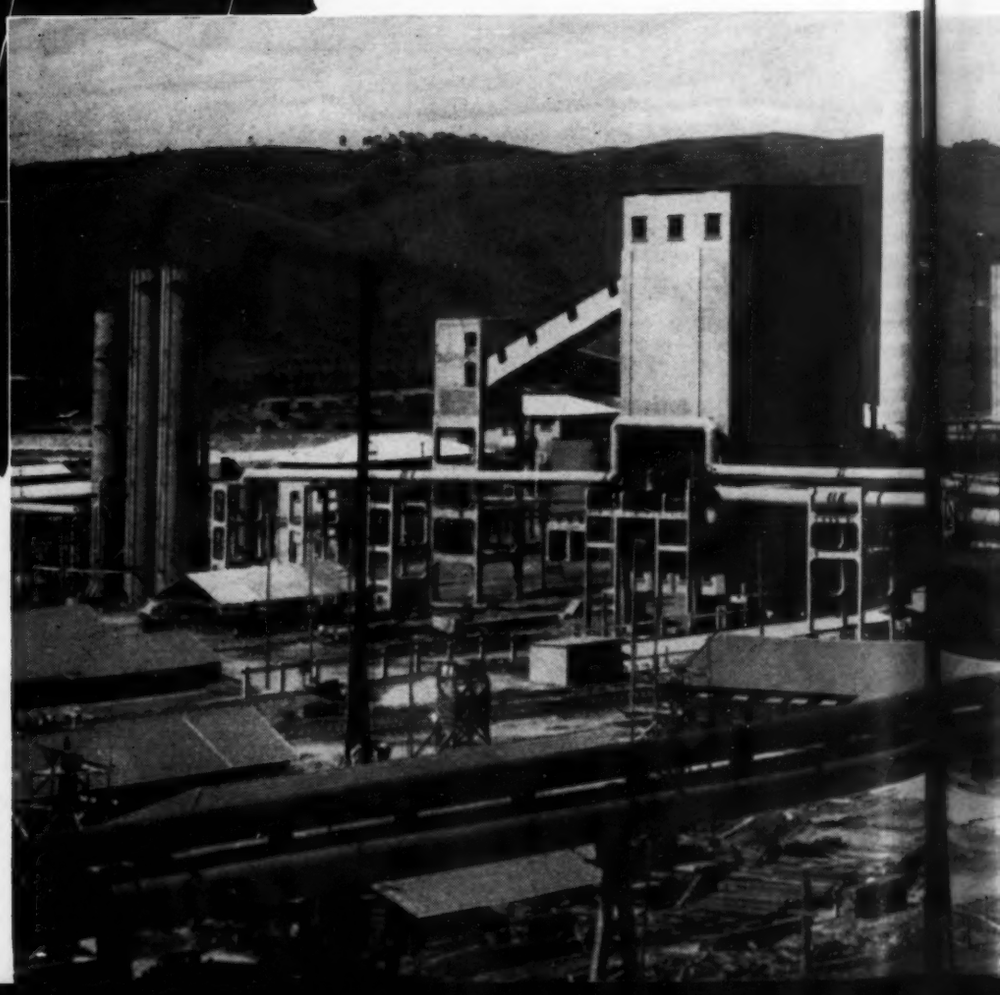


**3** Hoods and ash sluicing systems eliminate dust nuisance ordinarily resulting from firing pulverized coal in heating furnaces with inadequate draft provision.

# BABCOCK & WILCOX

**THE BABCOCK & WILCOX CO.**
**85 LIBERTY STREET**
**NEW YORK 6, N. Y.**

*The complete steel plant at Volta Redonda is the biggest ever started on the South American continent.*



# KOPPERS

## has built the *first* byproduct-coke-oven plant in South America

### *for the production of blast furnace coke from native coals*

In Brazil the rate of charcoal-iron production is the highest in any nation's history. However, charcoal is not strong enough to support the burden in a big modern blast furnace. For this reason the largest charcoal-iron blast furnace produces only 100 tons of iron per day.

The Brazilian National Steel Company therefore contracted with Koppers to build at Volta Redonda in Brazil, the first byproduct-coke plant in all South America. This work has been finished and the coke plant will soon go into production.

There are 55 Koppers-Becker Underjet Ovens, with Waste-gas Recirculation. These are big ovens, 15 feet in height, holding an average charge of coal slightly in excess of 20 tons. They will be underfired with a 110 B. t. u. mixture of blast-furnace gas and producer gas from Koppers-Kerpely gas producers or debenzolized coke-oven gas as the fuel balance of the mill dictates.

The plant will carbonize 570,000 tons of coal per year and will produce, in addition to coke and gas, ammonium sulfate, motor fuel, nitration-pure benzol and toluol, and xylol. A Koppers tar-distillation plant will make fuel tar, road tar, crude naphthalene, disinfectant oil, flotation oil, creosote and paving pitch, all for use in Brazil.

**KOPPERS COMPANY, INC.** • ***ENGINEERING AND CONSTRUCTION DIVISION*** • Pittsburgh 19, Pa.

FARREL

# ROLLING MILL DRIVES AND PINION STANDS

**FARREL-BIRMINGHAM heavy duty rolling mill gear units and pinion stands are specially designed to suit individual conditions. They are built to stand up under the stresses and shocks resulting from the high speeds and heavy loads encountered in modern mill practice, yet they are made with a high degree of precision to provide the smoothness of operation which is as essential in large mill drives as in smaller machines.**

**These drives have beds of cast steel, Meehanite or welded steel construction. Double-walled or single-walled deep base is used, depending on load conditions and rigidity requirements. Bearings may be either plain babbitt-lined steel cartridges or any approved make of anti-friction bearing.**

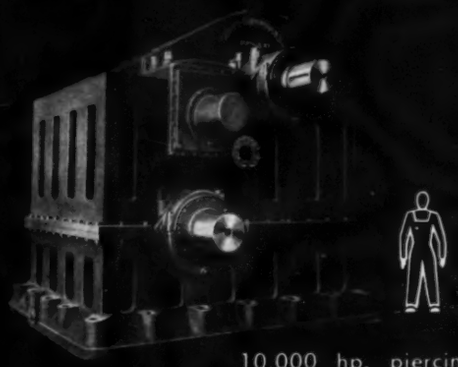
**Gears are usually continuous tooth herringbone — *The Gear with a Backbone* — accurately generated by the Farrel-Sykes process. Single helical or a combination of single and double helical gears can also be furnished. Dependent upon conditions or requirements, lubrication may be by dip and splash system, by pump built into the unit and driven by one of the shafts, or a separate lubrication system.**

**Our engineers will be glad to discuss drive problems with you at any time. No obligation of course.**

**FARREL-BIRMINGHAM COMPANY, INC.**
**ANSONIA, CONN.**

***Plants:* Ansonia and Derby, Conn., Buffalo, N. Y.**
***Branch Offices:* New York, Buffalo, Pittsburgh, Akron, Los Angeles**

1500 hp. reversing reel drive with the cover removed to show the Farrel-Sykes continuous tooth herringbone gears.



10,000 hp. piercing and expanding mill drive.

4000 hp. pinion stand for four-high reversing cold strip finishing mill.

Combined double reduction drive and 44" pinion stand for 40" x 108" reversing mill.

*Farrel-Birmingham*

NORTH AMERICAN FOR COMBUSTION

# HIGHER STANDARDS for EVERYONE

Good jobs, steady employment, high wages, shortened work hours, lower prices, improved products, insurance against sickness and old age, the material comforts of life are results attainable only by efficient production and distribution.

★

Progress will require the combined skill, effort, and co-operation of management, agriculture, and labor, the continued improvement through research of products and processes, the accumulation through thrift and saving of the necessary capital, and—most important of all—*progress will require a political and social atmosphere favorable to the continued growth and development of individual enterprise.* This last suggests government's contribution.

★

Wealth is the result of human personality, in the form of mental and physical energy, applied to the sunlight, the water, the earth and its contents.—These elements furnished by the creator of all things.

★

The abundant life is not a free gift from the mountebanks.

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES with FIELD ENGINEERS in PRINCIPAL CITIES
CLEVELAND 4, OHIO

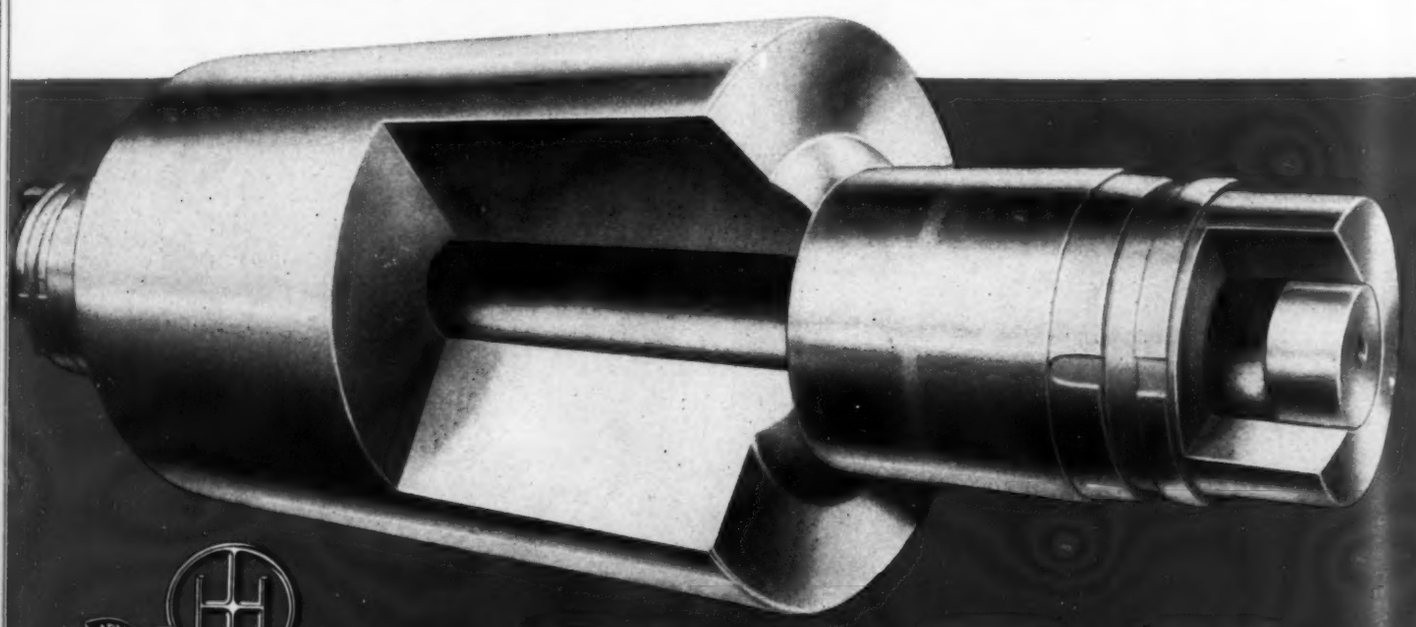
# "It's Steel!"

The strength, endurance, and dependability of steel are so well known that even kids like Billie say, *"It's steel!"* with pride.

Whether it's Billie's bike, mother's steel-sash windows, or father's car—or in any of the thousands of steel-made products of tomorrow—steel will benefit by the great respect that it has won.

But the buying public is impatient. Our industry must produce its products quickly for the peacetime markets that are waiting.

Since rolls are so important to the steel mill, Ohio is setting its sights on a roll production program that will keep pace with your demands. Our plants are ready —our engineering staff is ready. When you get the "Go!" sign, pass it on to us. We will be ready to produce rolls *right* in the shortest possible time.



ARMY E NAVY

*Select from any of these 9 types of Ohio Steel and Iron Rolls: Carbon Steel Rolls • Ohioloy Rolls • Ohioloy "K" Rolls • HOLL-O-CAST Rolls • Alloyed Iron Rolls • Duplex Iron Rolls • Nickel Grain Rolls • Hi-nickel Grain Rolls • Ringoff Rolls*

*Free Enterprise is the Only Way to Consistently Higher American Living Standards*

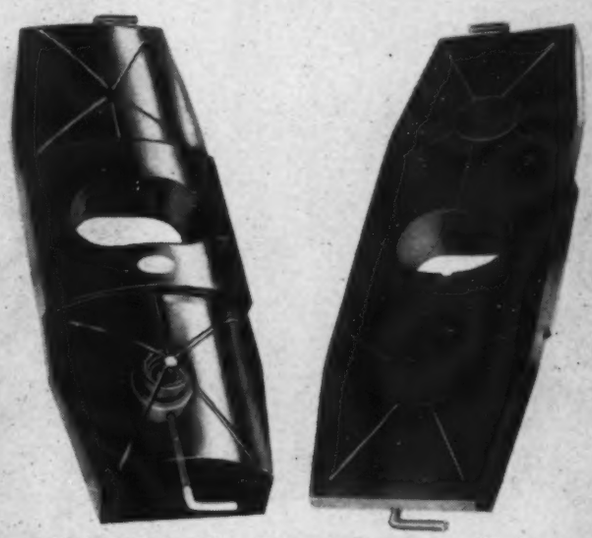
# Ohio Rolls

THE OHIO STEEL FOUNDRY COMPANY

LIMA, OHIO • PLANTS: LIMA AND SPRINGFIELD, OHIO

# 300% Faster Production of Tough Alloys with Gatke BEARINGS

GATKE Bearings are made of select fabrics and resin compounds, moulded to the required shape and size under heat and tremendous pressure. They are engineered for the application and made of correct material combinations for the particular service requirements, utilizing GATKE Know How, experience, and specialized facilities.



GATKE Self-Alyn-Slipper Bearings eliminate scoring and wear to companion surfaces. Stop deafening noises and troublesome grease-slinging. Absorb shock. Last ten times longer than bronze. Furnished to fit,—require no machining. Made for all sizes and types of Universal Couplings.

The superintendent of an alloy rolling mill credits a *300% increase in production* of the tougher alloys to the *low friction* of Gatke Bearings.

The equipment consists of conventionally arranged roughing and finishing mills independently driven by an 800HP motor and a 1000HP motor respectively. Both motors operate from a 900 KW generator driven by a 1200HP electric motor.

Due to the limited generating capacity the *great reduction in friction* effected by conversion to Gatke Bearings is reflected in *greater production rather than power saving.*

With metal bearings both mills were run simultaneously, but *one had to run idle until work cleared the other.* Even so, only 150 pound ingots of the tougher alloys could be worked in the roughing mill and 50 pound bars of these tough alloys were the limit for effective processing in the finishing mill. In both cases *larger ingots or bars caused excessive heating of roll necks and bearings.*

With Gatke Bearings reduced friction permits both mills to operate at maximum effectiveness. *Much larger* ingots of the tougher alloys are rolled and bars for the finishing mill have been *advanced from 50 to 130 pounds.* Yet it is not uncommon for three bars to be in process at the same time—one in the roughing mill, one in the earlier passes of the finishing mill, and another in the final passes.

Despite the incredible increase in rolling production, there is no serious overloading of the generator, with resultant excessive current demands, which had been prevalent with metal bearings.

Comparison of similar work before and after conversion shows roughing mill current demand reduced from 300 to 100 amps. and finishing mill demand reduced from nearly 400 to about 100 amps.

Furthermore, despite heavy operating schedules under today's severe conditions, replacement of Gatke Bearings is most infrequent, whereas metal bearings were replaced many times a year under the limited operation prior to 1939 when the conversion took place.

**GATKE CORPORATION**

**228 N. La Salle St., Chicago 1, Illinois**

# MOTOR MAINTENANCE—*Today's Important Factor*

NOW, more than ever before, it is extremely necessary that the electric motors, generators, etc., which play such a vital part in our production set-up, function smoothly and efficiently. This equipment cannot be easily replaced . . . preventive steps must be taken to prolong its life and guard against burnouts and failures.

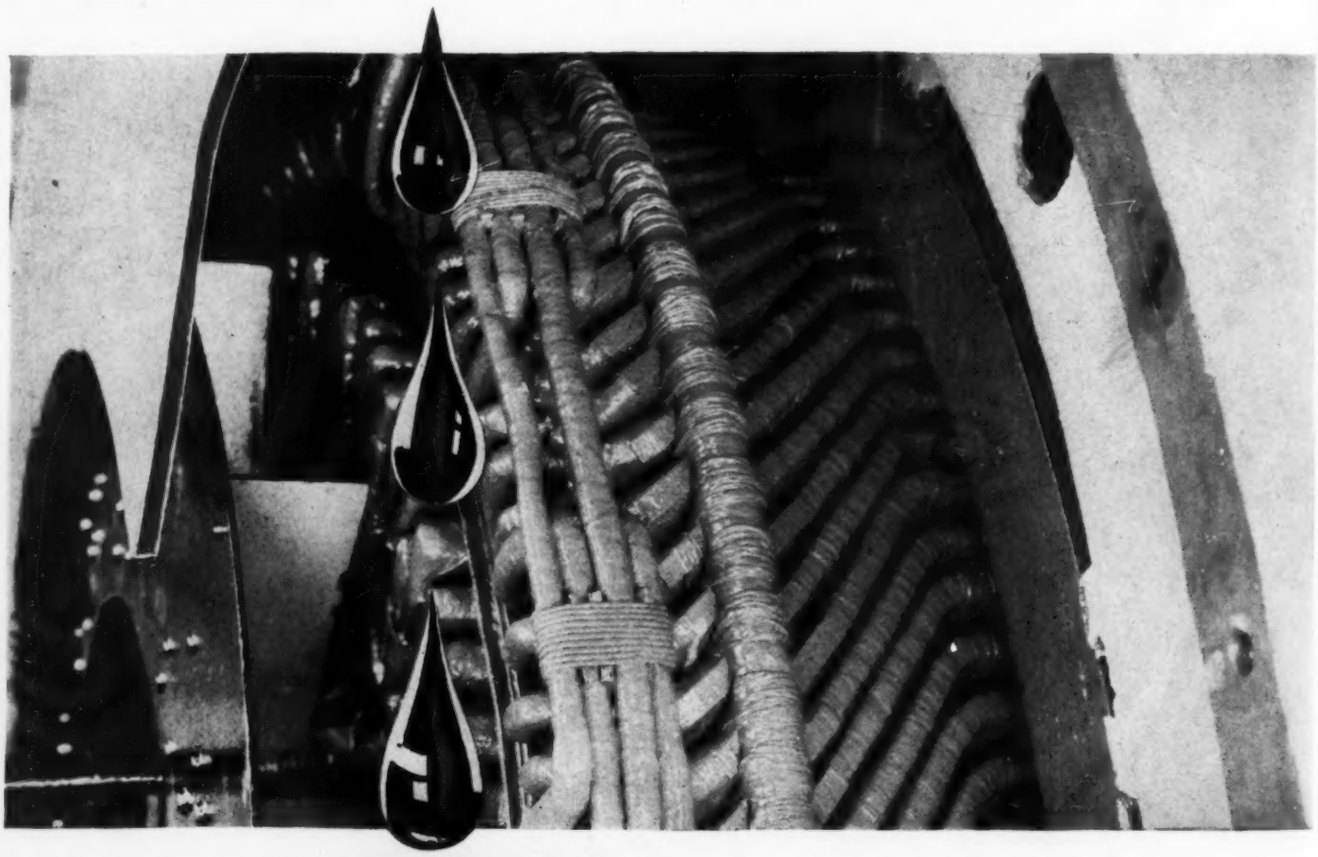
One of the prime factors contributing to motor failure is worn insulation. Holes and cracks develop in the original insulation . . . acids, oils, moisture and carbonaceous particles slowly break down the varnish film on windings . . . yet, this condition is quickly and efficiently overcome by renewing this insulation with a coat of DOLPH'S ELECTRIC LACQUER at regular intervals.

**ELECTRIC LACQUER,** a black air drying varnish, can be applied by either brushing or spraying. Air drying in 30 minutes, this material provides a high degree of resistance to oil, water and the abrasive action of dust particles.

The application of **ELECTRIC LACQUER** will not interfere seriously with your production, for it is not necessary to shut down electrical equipment except during the application process.

Let **ELECTRIC LACQUER** aid you in your preventive maintenance work, as it has for many others throughout industry.

# ELECTRIC LACQUER * (TRADE MARK REGISTERED)



*Insulating* Dolph's *Varnish Specialists*

**JOHN C. DOLPH COMPANY**

**168 EMMETT STREET • NEWARK 5, N. J.**

# ROCKBESTOS A.V.C.

## Provides a

# 5-POINT PROGRAM

## for Eliminating Wire-Failures

## in Lighting, Power and Control Circuits Exposed to Severe Operating Conditions

1. **National Electrical Code Type AVA** (max. operating temperature 230° F.) Rockbestos A.V.C. 600 Volt Boiler Room Wire in sizes No. 18 to 4/0 AWG. For lighting and control circuits around boilers, furnaces, steel mills, etc., and resistor wiring.
2. **National Electrical Code Type AVB** (max. operating temperature 194° F.) Rockbestos A.V.C. 600 Volt Switchboard Wire in sizes No. 18 to 4/0 AWG. For fireproof switchboard wiring. Takes right angle bends without cracking braid. Rockbestos A.V.C. Hinge Cable and Bus Cable also available.
3. **National Electrical Code Type AVA** (max. operating temperature 230° F.) Rockbestos A.V.C. 600 Volt Flexible Motor Lead Cable in sizes No. 18 AWG to 1,000,000 CM. For coil connections, motor and transformer leads exposed to heat and moisture, oil, grease and fire hazard.
4. **National Electrical Code Type AVA** (max. operating temperature 230° F.) Rockbestos A.V.C. 600 Volt Power Cable in sizes No. 18 AWG to 2,000,000 CM. For power circuits and hot-spot wiring in generating and industrial plants.
5. Rockbestos A.V.C. 600 Volt Multi-Conductor Control Cable in standard sizes, No. 12—19/#25 and No. 9—19/#22 (other strandings on order) with from two to nineteen conductors insulated the same as Rockbestos A.V.C. Power Cable except braids on individuals which are coded cotton.

Are repeated wire-failures tieing up equipment, slowing down production, and causing maintenance headaches? Then install Rockbestos A.V.C. heat and flame resistant wires and cables in the trouble spots.

These National Electrical Code type *permanently insulated* wires have the time-tested Rockbestos combination of lubricated varnished cambric and protecting impregnated felted asbestos insulation that stands up under high operating and ambient temperatures without baking brittle or flowing . . . without cracking open under vibration . . . without rotting or swelling when in contact with oil or grease . . . and without burning when exposed to flame. Rockbestos A.V. C. and other *permanently insulated* Rockbestos All-Asbestos (N.E. Code Types) wires, cables and cords are available in 125 different standard types . . . each designed specifically to give long life under severe service in lighting, control and power circuits . . . in boiler rooms, lehrs, steam tunnels, kilns, steel mill soaking pits and other hot-spot locations.

For complete information, samples and recommendations, write nearest branch office or:

**Rockbestos Products Corporation, 989 Nicoll Street**
**New Haven 4, Connecticut**

***FOR VICTORY—Buy War Bonds***

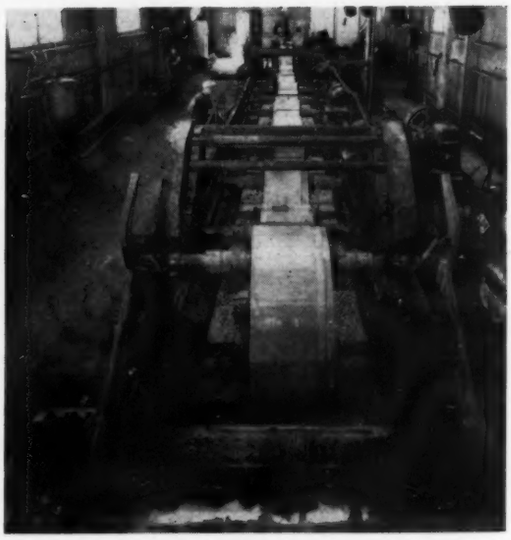
# ROCKBESTOS A.V.C.

## The Wire with Permanent Insulation

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

# CONTINUOUS PICKLING IN COIL FORM . . . a New Method

Coil entering pickle bath.



Pickling ten coils simultaneously.

STRIP steel in coil form has been pickled successfully by this method for five years in the plant of the Greer Steel Company, Anderson, Indiana. We have acquired the exclusive manufacturing and sales rights to this pickler, and it is available by outright purchase.

- Finest pickling quality.
- Lower operating costs.
- Greater tonnage.
- Less floor space required.

Built under one or more of the following patents: Re 22,296, 2,091,921, 2,096,512, 2,120,843, 2,176,900, 2,191,463, 2,196,210, 2,199,412, 2,216,211, 2,220,097, 2,250,494, 2,257,133, 2,257,743, 2,257,760, 2,261,178, 2,265,067, 2,269,454, 2,270,892, 2,273,884, 2,275,458, 2,278,477, 2,288,621, and other patents pending.

**Sole Licensee**

## THE ARMS-FRANKLIN CORPORATION

Engineers and Builders of Rolling Mill Machinery

YOUNGSTOWN 3, OHIO

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Iron AND Steel ENGINEER

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## THE DENSITY OF OPEN HEARTH BOTTOMS

*by* ROLAND B. SNOW, Research Laboratory
United States Steel Corporation, Kearny, New Jersey

*Condensation of paper presented before Chicago meeting of American Institute of Metallurgical Engineers, April 27, 1945*

▲ Preliminary examination of a considerable number of specimens shows a wide variation in the bulk density of specimens taken from rammed bottoms and from a burned-in magnesite-slag bottom. Many open hearth bottoms are now of the cold-rammed type, which can be installed in much shorter time than the older burned-in bottom. There is, however, likely to be a wide variation in ramming time between different layers in the same furnace, as well as between one shop and another. Bulk gravity of two core drill specimens taken from a representative furnace was 2.47 and 2.49 or 154-155 lb per cu ft.

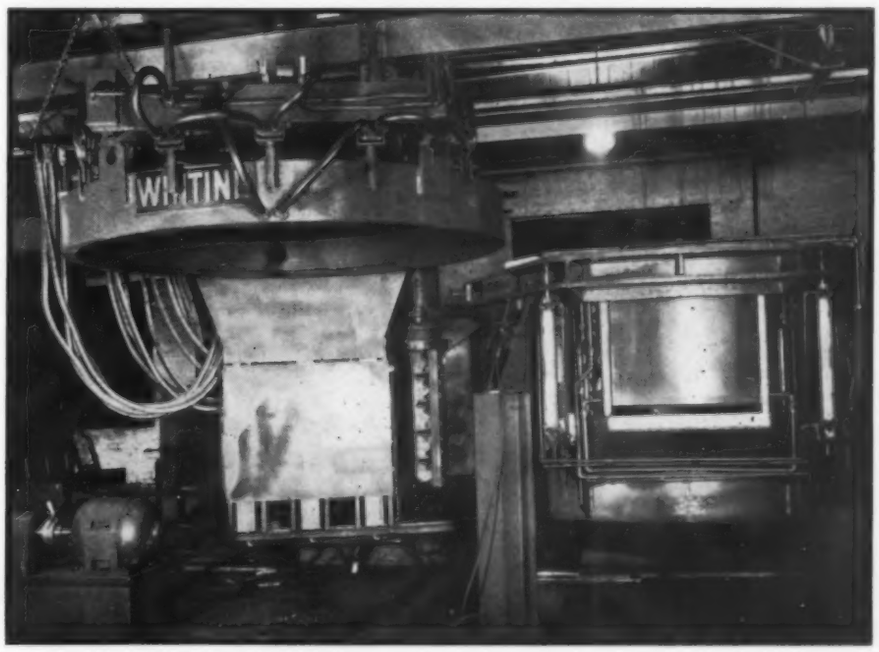
Initial tests designed to determine the minimum ramming time necessary to bring a layer of given thickness to maximum or near-maximum density have now been completed by certain producers of refractories. If several rammers are used continuously, and if desirable conditions are maintained, it should be possible to put in a hearth in a short period and still be assured of a well-rammed bottom. It may also be possible to add an extra 5 or 10 lb of material per cu ft if more work be done on each layer. Tests show that a density of 2.57 to 2.62 (160-164 lb per cu ft) can be attained.

The pressure and impact of the rammer is influenced by the size of the rammer head, the air pressure, and the number of blows per minute, and these variables must be controlled in any study of the obtainable density. Similarly, proper distribution of the bonding materials and fines in the mixture is essential.

Since 1938 a number of hearths have been installed in United States Steel Corporation furnaces using fine ground magnesite with 10 percent or less of fine slag. In the past, when coarse grained magnesite was used, the larger voids between the grains became filled either with melted slag or by recrystallization and deformation of the granules, processes which require high temperature and extended time. With fine magnesite and fine slag, the particles are already close together and the time between doses in building up a bottom by thin layers can be reduced to two hours. A core taken from such a bottom after 125 heats showed a bulk specific gravity of 3.12. When the mix is used for hot patching, a thin original layer is applied and succeeding layers are added at intervals of approximately 20 minutes.

A dense bottom can be burned in with coarse magnesite and slag, but it takes a number of days. It is believed, however, that a satisfactorily

## ARC FURNACE USES HYDRAULIC ELECTRODE CONTROL



**Whiting Corporation, Harvey, Illinois, recently announced the completion of a new swing-aside, top-charge electric furnace which has hydraulic, air counter-balanced, electrode positioning control. This new design uses small cylinders of standard make to raise and swing the roof. The weight of the electrodes, electrode arms, and electrode arm supports are not supported by the furnace refractories but are suspended from the swing column at the side of the furnace at all times — the weight of the roof only (which is picked up at four points) is distributed uniformly and symmetrically over the entire periphery of the wall refractory.**
**This furnace has a capacity of 12,000 lb and a melting rate (acid steel practice) of 6000-8400 lb per hour. It uses a 3,000 kva transformer and is being installed in a Muskegon, Michigan, war plant.**

dense bottom can be built with fine magnesite and fine slag, and that this material can be put in rapidly enough to compete with a rammed hearth, especially where labor is not available for a fast ramming job. At several open hearth shops, layers of 4 inches of magnesite plus 10 per cent of slag have been put in in 30 hours and it is possible that the additions could have been made more rapidly.

While the cold-rammed bottom does not receive the thorough firing that is characteristic of the burned-in bottom, it does receive some preliminary heating, varying in intensity and time in different shops. There are disadvantages to any method of thorough firing. To sinter in the material requires a high temperature and measurements show that the heat which the hearth has absorbed during the burning-in is quickly dissipated during the first few heats. Shrinkage cracks, therefore, form in the cooler portion of a solid magnesite-slag working bottom, and in addition, expansion and contraction of the brickwork can occur. In the case of the rammed and pre-fired bottom the surface layer has had its shrinkage removed by the high temperature and the vertical cracks are filled with a liquid or low-fusing slag. The layers below the dense surface are porous unless the pores have been filled with slag or low-fusing products from the sintered layers above or closed by pressure of the metal and bottom material.

Volume stability of ramming mixes indicates that shrinkage cracks and thermal cracks probably do not form in the rammed layers immediately above the brick unless the burning-in period is unusually long.

Examination of lump samples and drill cores from new and old bottoms, both of the burned-in and cold-rammed types, shows that the rammed bottom falls considerably short of attaining the density of a burned-in bottom. Too thorough heating of the rammed bottom, on the other hand, results in penetrating shrinkage cracks, as well as cracks due to thermal contraction when the bottom reverts to the temperature gradient associated with normal operation.

For better steel.. and more of it
HAYS
TELLS YOU AT A GLANCE
★ AMOUNT OF AIR FLOW AND FUEL FLOW
★ PERCENTAGE OF AIR EXCESS OR DEFICIENCY
HAYS VISIO RATIO GAGE
the HAYS VISIO-RATIO GAGE
IT'S A GOOD "steel man"—this truthful reporter of combustion facts. It's infallible—made to be.
It saves man hours—does away with time-consuming calculation of air excess or deficiency and all need for experimental adjustments.
It saves fuel—indicates instantly any faulty proportion of air and fuel.
It saves material—makes for greater uniformity, and for less spoilage.
It helps you get better steel—and more of it.
ADVANTAGES
Advantages of Hays centralized control of open hearth furnaces are set forth in Publication 43-586.
Useful literature—better send for it.
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.


## PORTABLE CART DISPENSES LUBRICANT

▲ Designed to provide a complete, compact, portable lubrication department for industrial plants, with unique ability to transport and dispense a variety of grades or types of lubricants, a new Lubrikart has been been announced by the Alemite division of the Stewart-Warner Corporation.

The new unit, mounted on five-inch ball-bearing casters, is only twenty-one inches wide. It is thirty-one inches long and thirty-seven and a half inches high. Pushed like a perambulator, it is intended for one-man operation and is able to travel between rows of machines or elsewhere in a plant where space is limited.

The new Lubrikart comes in two models. The basic model carries two seven-gallon tanks equipped with low pressure pumps with five and a half foot hose and non-drip nozzles for filling oil reservoirs on machines or hydraulic systems, and for filling gear housings; one seven-gallon tank with high pressure pump for loading handguns; two one and three-quarter gallon tanks with oil transfer pumps

for filling oil cans; six spout-type oil cans, and, four lever-type handguns. There is also space for waste, replacement fittings, small tools or other material.

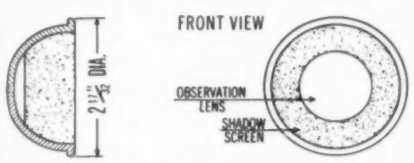
The second model has, in addition to the foregoing equipment, a high-pressure, hand-operated grease pump which holds thirty pounds of lubricant and has a five and a half foot lubricant hose fitted with a hydraulic coupler. This pump develops up to 7,000 pounds of pressure per square inch, and can be lifted clear of the Lubrikart and carried to point of use, if desired. All pumps, loaders and transfers are manually operated.

Outstanding advantages of the Lubrikarts, according to Alemite engineers, are their ability to transport many types of lubricants and a variety of equipment for application of lubricants; high degree of maneuverability; time savings due to less frequent return to the oil storage room by the lubrication attendant, and, greater assurance that lubrication will not be neglected by the lubrication attendant because of lack of proper lubricant or equipment at point of use.

## LENS FOR VIEWING FURNACE INTERIORS

▲ The Ess Instrument Company of Ft. Lee, New Jersey, announces the development of a new lens, for its Cat's-Eyes, to permit visual inspection of boiler and furnace interiors and their contents, while in operation.

TYPE "O" LENS FOR OBSERVING FURNACE INTERIORS AND PARTS




When visual inspection of furnace interiors or contents is desired, type "O" Lens provides a wider field and less reduction. When a glance inspection from a distance is desired, type "G" Lens, shown in models "A" and "C" should be used. Since these lenses are interchangeable either type can be furnished.

This new lens (type O) provides a wider field of vision with less reduction than is available through a standard type G lens. Both are interchangeable.

Cat's-Eyes equipped with type O lenses will show at a glance from distant points the flame with its characteristics of color, turbulence and haze, and objects inside a boiler or furnace such as tubes, articles being heat treated, etc.


# Schloemann "MOTOR-ROLLERS" Increase MILL TABLE EFFICIENCY

SCHLOEMANN engineers have designed "Motor-Rollers" to increase efficiency and lower operating costs by simplifying electrical and mechanical requirements.

Each Schloemann "Motor-Roller" is individually powered by a squirrel cage motor, housed in a free turning shell on anti-friction bearings, assuring flexibility of movement. The stator has no electrical connection to the rotor and represents the simplest piece of apparatus for converting electrical energy to mechanical work.

Our engineering staff is prepared to assist you with your mill table problems. We invite your inquiries for additional information or consultation with our representatives.

"Motor-Roller" installation in a shear depressing table.

**OTHER SCHLOEMANN PRODUCTS**

Air-Hydraulic Accumulators • Accumulator Controls
Complete Hydraulic Systems • Extrusion Presses

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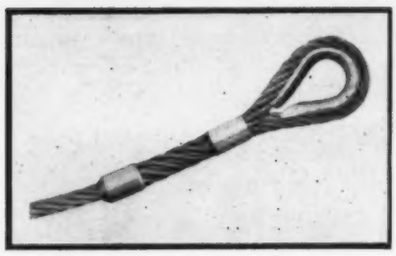
1102 EMPIRE BUILDING . . . . . PITTSBURGH 22, PA.
HYDRAULIC PRESSES • ROLLING MILL MACHINERY

## IMPROVED SPLICING METHOD FOR CABLE

▲ American Chain and Cable Company, Inc., Bridgeport, Connecticut, announces the development of a new method for splicing preformed wire rope into slings or various assemblies — a method which renders hand-tuck splicing obsolete and unnecessary.

This method develops a neater and more compact splice than is possible by the hand method. The splice is flexible clear to the terminal, and always develops 100 per cent of the rope's strength. The Acco-Loc safety splice does not distort the rope structure and so maintains equalization of stresses in all strands. The splice applies the load stress in direct line with the pull of the load. It has no seizings to loosen, unravel or get in the way; no wire ends to barb and tear workmen's hands. It is wide open for visual inspection at all times. It may be used with any standard fitting (hook, ring, shackle, thimble, etc.), and when the sling or assembly



is retired such fittings may be salvaged and re-used. At the present time the new Acco-Loc safety splice can be applied only at the factory.

The company has also introduced wire rope that is entirely covered with a green-colored lubricant for their two wire rope divisions, the American Cable Division and the Hazard Wire Rope Division.

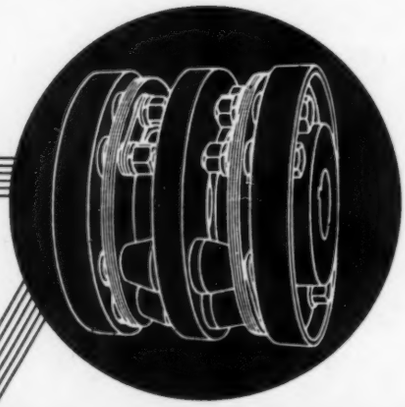
American Chain and Cable has long identified its ropes made of improved plow steel with a single green-colored strand. Emerald-green having been adopted as the Acco color, American Chain and Cable established a formula for a superior lubricant colored green for use as its identifying strand. That this green lubricant was definitely superior to ordinary black lubricants has been proved by years of field service. Ropes having the green strand, retired from all manner of service and returned to the mill for inspection and testing, revealed that wires protected with the green lubricant were in far better condition than the wires under the black lubricant in adjacent strands.

American Chain and Cable's "Green-Lube" has high viscosity and remarkable capacity for adhesion to the surfaces of the wires. It has a grease-like consistency at normal temperatures and is applied hot and in a molten state by the pressure method which not only assures complete coverage of every wire but the filling or "stuffing" of the voids between wires. Thus it better protects the wires, enables them to adjust themselves more easily, adheres to the wires longer and thereby develops longer rope wear.

## NEW PUSH-BUTTON COMPACT, OIL-TIGHT

▲ To meet a rapidly growing demand, the industrial controller division of the Square D Company, Milwaukee, Wisconsin, has just introduced its new line of class 9001 type T oil-tight pushbuttons, de-

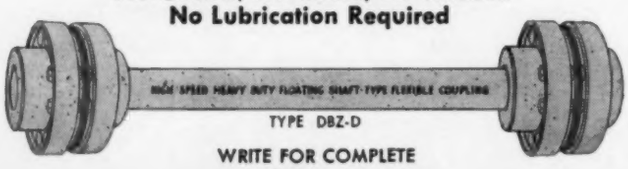

THOMAS
Flexible COUPLINGS



TYPE DBZ
TYPE DSM
TYPE CM
TYPE AM
TYPE-MT
TYPE SS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



TYPE DBZ-D
WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

signed primarily for group mounting on machinery or control enclosures. Field and laboratory tests involving millions of operations were conducted to prove the oil-tightness of the new units. Tests were made with oils, coolants and cutting compounds, under more severe operating conditions than encountered in actual use.

While oil-tightness is the principal feature of this new line, there are several other worthwhile advantages. Although the new type T units are more compact and can be mounted on closer centers than previous types, there has been no sacrifice of accessibility. All terminal screws can be reached with a screw driver without going in at an angle.

Quick, easy installation is another important advantage. The unit is inserted through the panel and prevented from turning by a dowel. After the legend plate is slipped on, a thread ring firmly clamps the unit into position.

Still another feature is the unusual flexibility of this new line. Since the operating mechanism and the contact block are separate units, it is possible to obtain a combination to cover a wide range of circuit requirements with a limited stock of three types of operators and four types of contact blocks.

## ALLOY GIVES STRENGTH TO CAST CONNECTORS

▲ The adoption of a new, high-strength alloy for all cast, current-carrying parts of electrical connectors has just been announced by the Burndy Engineering Company, New York, New York. This alloy, known as Burndy 113L, is the same as Burndy's familiar high copper alloy 113, but with the important addition of Lithium.

This addition of lithium is said to provide a far denser and fine-grained casting, with an increase in tensile strength of almost 20 per cent. Elongation is also increased about 20 per cent. The coefficient of friction is reduced, yet all these advantages are obtained without any appreciable change in electrical conductivity.

Electrical connectors cast from alloy 113L, it is claimed, are therefore stronger and tougher, overcoming cracking in service, are more readily comformable to the conductor, and can be installed with greater applied pressure.

SPRING MOUNTED

IS THE ANSWER!

**For shock loading or where very heavy loads must be handled on Roller Conveyer, Mathews Spring-Mounted construction should be considered. Spring-Mounted Roller Conveyer is made in three styles, and is establishing service records in heavy industries all over the United States and Canada. Your Mathews Field Engineer can explain how it works and why the Mathews design is superior to other available types of Spring-Mounted Roller Conveyer. He can tell you how its application has minimized the costly maintenance which is usually necessary on Roller Conveyer used under very severe conditions. You will readily understand how the principle of pre-compression protects the bearings and axles of the rollers, yet, at the same time, prevents any bouncing action from taking place. Descriptive literature is available on request.**

Mathews Conveyer Company
ELLWOOD CITY, PENNSYLVANIA

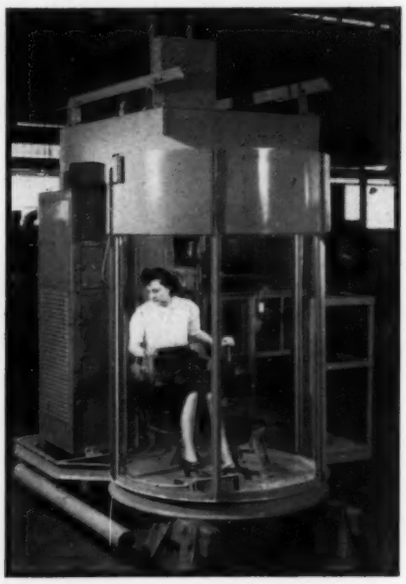
MANUFACTURERS' ASSOCIATION, INC. EQUIPMENT

## MODERN CRANE CAB FOR NEW OR EXISTING CRANES

▲ A radical innovation in cab design for overhead traveling cranes, developed by the Cleveland Crane and Engineering Company, Wickliffe, Ohio, provides full vision for the operator, comfortable sit-down control and air conditioning.

The cab is the greatest step forward in crane design since the advent of the all-welded steel crane construction also pioneered by Cleveland Crane. Cylindrical in shape, it is modern streamlined in appearance. Corners or blind vision spots are eliminated. Ample room is provided with no waste space.

The transparent enclosure panels extend to the floor permitting maximum vision in every direction over the area covered by the crane. The panels are of a new plastic which is shatter proof and impervious to certain gases common in many plants that may be injurious to glass.



**This revolutionary Cleveland Crane cab is 6 ft-6 in. high by 4 ft-6 in. diameter and is equipped with Electric Controller and Manufacturing Company master switches and Lintern Aire-Rectifier. The traveling platform makes cleaning of the entire window easy and safe.**

With this cab, crane operation becomes an easy, sit-down job. Master switches especially designed for magnetic control are located for greatest convenience. Hoist and trolley switches are attached to the right and left arms of the chair. The bridge switch is on the floor and controlled with the right foot. Thus there is a definite control job for each of the operator's hands and feet, but none of his limbs need serve a double duty as in most conventional cabs.

An air-cooled air-conditioning unit, especially designed for this cab, provides fresh clean air at any normal temperature desired and gives protection against objectionable gases, dusts and fumes. The unit attached to the cab illustrated is for use where temperatures do not exceed 140 F. Adequate sealing and insulation is provided to assure against excessive losses.

A novel feature is the traveling platform which serves both as vestibule to the cab and a means for easy access to the entire exterior side of the window for cleaning purposes. Safety locks on both platform and cab door prevent operation of either except when platform is in proper position.

This new cab is a self contained unit that may be furnished with any new crane employing magnetic control and it may be applied to existing cranes of any make.

## ACCURATE CONTROL FOR ELECTRIC FURNACE

▲ The development of a vacuum-tube thermocouple device characterized by its anticipating nature, increases the sensitivity and response of conventional temperature controls by a thousand per cent, according to M. J. Manjoine, research engineer at Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, who invented the device. The instrument consists of two thermocouples of different thermal capacity and an electric heating element, enclosed in an evacuated glass envelope to cause heating of the thermocouples by radiation, to minimize room temperature effects, and to prevent deterioration of the elements. Changes in electric furnace temperatures are anticipated and corrective steps taken to minimize the cyclic swings in temperature characteristic of most furnace controls.

As an example of the efficiency of the device, a heat-treating furnace varied over a range of 50 degrees F (plus or minus 25 degrees) prior to supplementing the control with this anticipator. After connecting and adjusting the anticipator the variation was five degrees F (plus or minus two and one half degrees).

When the temperature of a furnace is controlled by a single thermocouple within the heating chamber, the temperature rises sharply until it reaches a predetermined point where the control operates to disconnect the furnace from the power line. Because of the large thermal capacity of the heating elements and the furnace itself, the temperature continues to rise — but less sharply — to a maximum and then begins to fall. At a preset minimum temperature which may coincide with the maximum, the controls again connect the furnace to the line. Here again the flywheel effect of the furnace thermal capacity causes the temperature to continue to drop until a minimum is reached at which point the temperature again begins to rise. The overshooting on the heating and cooling portions of the control cycle result in a considerable temperature range between the high and low temperatures of the cycle.

The anticipator, because of the different characteristics of the thermocouples used, reacts to temperature changes quicker than the furnace and initiates the control operation sooner and minimizes temperature fluctuation. The two thermocouples in the instrument and the control thermocouple in the furnace are connected in series so that the polarity of the couple with less thermal capacity is additive and the couple with greater thermal capacity is subtractive with respect to the furnace couple.

The heating element of the instru-

ment is energized by the power source connecting the control mechanism and the relays that operate the main power contactors. Thus the furnace and instrument heating elements operate together. The two couples in the instrument are equidistant from the heater but the element with the lesser thermal capacity reacts first to changes in heater element temperature.

When the two couples in the anticipator are at the same temperature, the voltage from the control thermocouple to the control mechanism is constant. At the time that the control thermocouple institutes a change in control current, for example, starts the heating part of the cycle after having been off, the change is felt first in the two thermocouples in the anticipator. However, the thermocouple with the lower thermal capacity heats faster than the other and the thermocouple voltage at the temperature control mechanism is increased. This increased voltage causes the controller to change to cooling, thus preventing the furnace temperature from overshooting the desired maximum. When the opposite action takes place and the furnace is in the cooling portion of the cycle, the anticipator thermocouple with larger thermal capacity cools more slowly and its reversed polarity causes the control mechanism to change to heating and keep the furnace temperature from overshooting the minimum limit.

Should the line voltage dip (or rise) the instrument heater reflects this change much quicker than the furnace heating elements and the control is properly energized to correct for the power variation before the need is recognized by the thermocouple in the furnace.

## MECHANICAL CONTROLS REMOTELY OPERATED

▲ A standardized system of remotely operated mechanical controls has been announced by M. L. Bayard and Company. The control system is used on such equipment as cranes, winches, windlasses and steering gears for opening and closing large valves or ventilators, and for the operation of banks of furnace doors, factory windows, etc.

The related units are suitable for power operation under speeds not

On land and sea and in the air . . . wherever liquid, air or vapor lines must swing or turn to provide for movement of equipment, vibration or easy handling . . . CHIKSAN *Ball-Bearing* Swivels render safe, dependable service.

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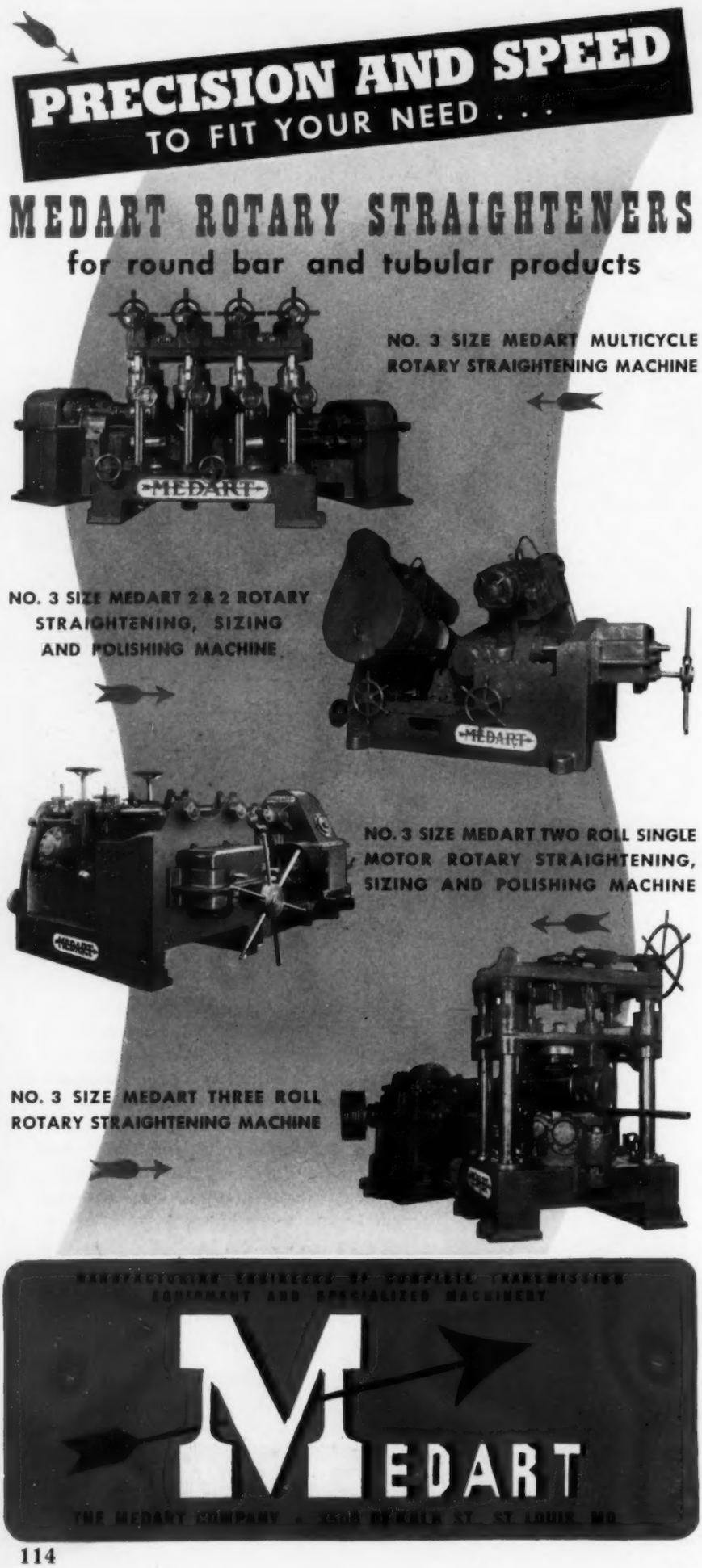
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exceeding 1800 rpm. Terminal connections are constructed so that rearrangement of the same units can be made without disturbing the assemblies or affecting their internal adjustment.

The steady shaft assembly is engineered in two standard types. One is for attachment to a surface which is square to the shaft. The other is for attachment to surface which is parallel to the shaft.

Full freedom is possible with the spiral bevel gear assemblies because all shaft ends are interchangeable. Either two shaft ends or three shaft ends, depending upon the type desired, are connected to other control units.

The universal shaft assembly is made in lengths ready to be installed, or with one end-yoke to be field welded after the tube is cut to suitable length. Telescoping splined portion between the end yokes permits ready installation and removal without disturbing the other control units. Further information may be obtained from M. L. Bayard and Company, 1934 Indiana Avenue, Philadelphia 32, Pennsylvania.

## FIFTH ARMY-NAVY STAR FOR PRODUCTION RECORD

▲ The fifth white star now proudly graces the Mesta Machine Company's Army-Navy "E" flag, indicating the success of the company's efforts to supply the fighting fronts with vitally needed war materials. Mesta is the first company in the Pittsburgh District to be so honored.

In advising president Lorenz Iversen that Mesta had merited the 5th star award, Admiral C. C. Bloch, USN (Ret.), Chairman of the Navy Board for Production Awards, stated:

"It is with heartiest congratulations that the Army and Navy inform the men and women of the Mesta Machine Company that a fifth renewal of the Army-Navy "E" award was granted your plant at the last meeting of the Navy Board for Production Awards.

"This award, signified by the five stars to be displayed on your "E" flag, is an indication that all of you have maintained the excellent record of production which merited your pre-

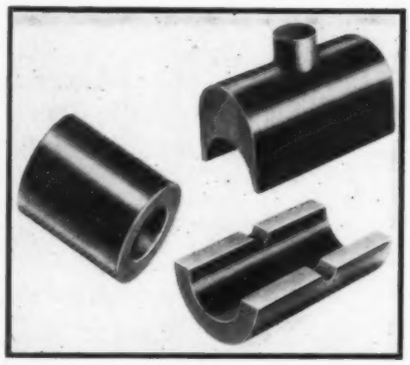
vious awards. Each and every one of you may well be proud of this high honor and inspiring record.

"The courageous men on the fighting fronts must have the necessary weapons with which to wage total war. These men appreciate the vital support of the men and women of the Mesta Machine Company who have worked with such untiring effort on the production front to supply these needed war materials."

Mesta Machine Company on September 11, 1941 was one of the first to be given the Navy Bureau of Ordnance "E" Award. They later received the all-Navy "E" Burgee and subsequently the Army-Navy "E" to which has now been added the fifth star. Each of the five stars signifies recognition of a continuation of outstanding war production which merited the initial honor.

## SELF-LUBRICATING BEARINGS HAVE WIDE APPLICATION

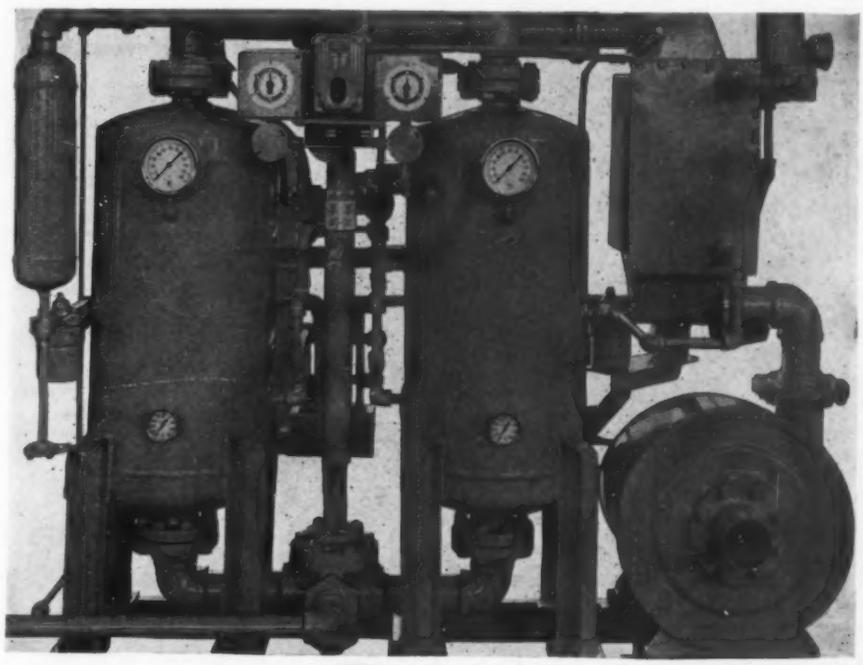
▲ Versatile self-lubricating bearings, in compositions of carbon, graphite or both, or with various metallic contents for special applications, are available from Morganite Brush Company, Inc., Long Island City, New York.



Bearings of these materials have unique properties — self-lubrication, immunity to acids, alkali and most solvents. They have low coefficients of friction and expansion. Wear is negligible on the part of the bearings as well as contacting surfaces. In operation, Morganite bearings glaze cooperating surfaces with a protective coating. They impart no odor or taste to liquids and are highly desirable and widely used in chemical and food processing industries.

Morganite bearings are readily machineable but may be molded with tolerances to .001 in. They can be machined to close accuracy when desired, or super-finished. Outside diameters of ⅛ in. to 15 in. are permissible. They may be supplied in any shape — complex sleeve or split types, with any contour required. They may be plated, take moulded-in fastenings and can be shrunk, press fitted, or vulcanized to rubber.

Operating speeds to 50,000 rpm with thrust loads to 30 psi or loads to 2000 psi at slower speeds are possible. Warpage and change of shape are practically non-existing factors. Because of inherent self-lubrication, they are widely used in inaccessible locations. Also their immunity to high heat (to 850 F) has resulted in wide use in steam turbines, drum dryers, and paper mills where ordinary lubrication usually is impaired or a contaminating influence.

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DRY? Kemp DYNAMIC Adsorptive Dryers will efficiently dry air or gases to sub-zero dewpoints for critical applications where DRYNESS is mandatory.

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**Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore 2, Maryland.**

**KEMP of BALTIMORE**

## TANKS ENLARGED WITHOUT DISMANTLING

▲A new method by which liquid storage tanks may be enlarged to as much as twice initial size without dismantling the original structure has been developed by the Stacey Bros. Gas Construction Company, Cincinnati, Ohio, one of the Dresser Industries.

The old tank is literally boosted to new capacity height, as new rings are added at the base by a patented process which makes use of virtually all of the original structure in assembled form. Such reuse, along with the utilization of the original foundation and the minimum dislocation of connections, contributes much to the economy of the process as well as to the speed with which a job may be completed.

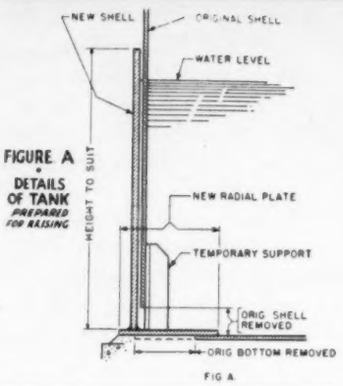



FIGURE A
DETAILS OF TANK PREPARED FOR RAISING

FIG A.

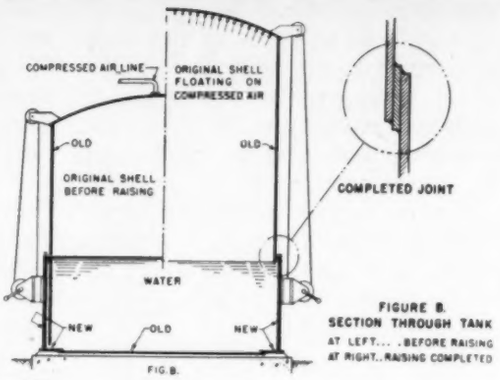



FIGURE B.
SECTION THROUGH TANK
AT LEFT.... BEFORE RAISING
AT RIGHT.. RAISING COMPLETED

FIG B.

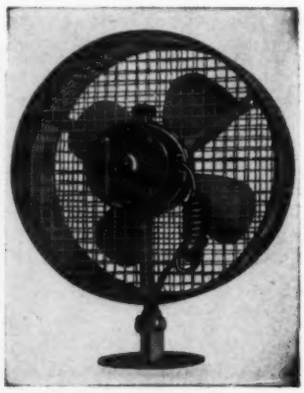
Providing for the first time an alternative to new tank construction to increase storage capacity, the Stacey Bros. method will be particularly useful where facilities are crowded and there is room only for expansion upward.

As much as 100 per cent additional capacity may be added by Stacey men, who cut the existing tank shell at the base, add new radial plates, and build a new shell around the old structure to give the desired height. Water is then run into the tank up to the new shell level, so that compressed air may be introduced to float the old cover shell up to the new level. Various controls hold the tank steady and level to 1/16 in., while 4 in. filler plates are inserted between the shells, and the two units are tack welded in place.

When air pressure is released, and the water drained from the tank, the two shell sections and fillers are completely seal welded on the outside. Inside, the old shell is trimmed and welded at intervals around its circumference, and the enlarged tank is ready for connections and service.

Originally developed to obtain better buoyancy control of petroleum storage tanks in areas subject to flood, the new method can be used to build up tanks having either umbrella type roofs, or roofs supported by center columns. The inherent economies of this method are expected to be of widespread significance in the busy days ahead.


IS HEAT SLOWING UP YOUR WORKMEN?



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Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool are *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

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TRUFLO FAN COMPANY
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## ETHYL SILICATE FOR REFRACTORY SURFACING

▲ Ethyl silicate is used in large quantities as an investment bonding agent for precision casting of special alloys. It is also useful to surface-harden graphite and sand molds and as an acid-resistant binder for brick, mortar, and other refractories.

Ethyl silicate is mixed with water and with a denatured ethyl alcohol such as "Synasol" solvent, and the mixture is allowed to stand for twelve hours. The aged solution can then be mixed with powdered ceramics to form a slurry, or diluted with alcohol, and sprayed on the surface to be hardened. Upon application of the solution, the alcohol is set free by gradual evaporation at room temperature, or it can be baked out, leaving a form of sticky colloidal silica that dries to a hard vitreous-like material.

Such a cement or bond of pure silica has several advantages. It is neutral, it does not dissolve in water, and it has no chemical action upon the surrounding material. It is acid-resistant and is not affected by high temperatures or by ordinary chemicals, except strong alkalies.

Porous sand molds coated with ethyl silicate solution are strengthened, hardened, and stiffened by the deposited silica. To obtain a smoother surface, some filler may be incorporated in the ethyl silicate solution.

In the more accurate casting of such metals as magnesium, an ethyl silicate solution is used as a mold wash. For this purpose, it is sprayed on the inner surface of a conventional two-part sand mold and allowed to dry. Such treatment results in improved casting surfaces, without attendant sand inclusions.

The "permanent" graphite molds, used for making certain non-ferrous castings, deteriorate rather rapidly because of the action of the hot metal on the mold surface. Impregnating the surface of these molds with ethyl silicate solution should increase their life.

Steel castings are sometimes coated with finely ground ferro-chrome by pouring the molten steel into sand molds coated with the ferrochrome. Ethyl silicate can be used to bond the powdered ferrochrome to the surface of the sand mold.

If pulverized silica is mixed with hydrolyzed ethyl silicate solution and then allowed to air-dry, a hard, strong, slightly porous, refractory and acid-resisting material is formed. Air-dried blocks produced by this method withstood a crushing load of over 2,000 psi and a temperature of 1,500 C. On heating and subsequent cooling, the strength of the blocks was reduced somewhat, but no spalling or serious deterioration developed.

## ENGINEERING FIRM MOVES QUARTERS

▲ After a tenure of two decades at its old address, Freyn Engineering Company has moved to new quarters at 58 East Washington Street, Chicago (2), Illinois. The company will occupy the entire fourteenth floor of the Garland Building, where quarters have been reconstructed to suit the company's requirements.


In **hazardous locations** where ordinary floodlights are unsafe because of the presence of explosive atmospheres, you can solve the problem by installing

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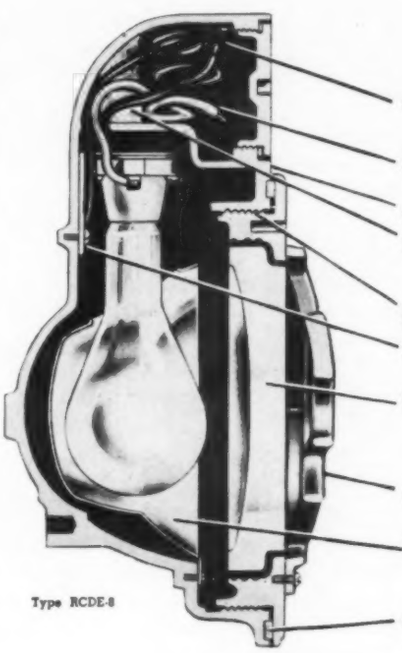
*Explosion-Proof*

**FLOODLIGHTS**



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**Asbestos covered leads.** One wire is grounded to housing for safety circuit.

**Cast aluminum** or Feraloy (semi-steel) housing.

**Factory sealed** with sealing compound between wiring chamber and lamp housing. External seals unnecessary.

**Flame tight threaded covers.**

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**Sturdy grid** for use where glass is exposed to breakage. Easily removed for cleaning lens.

***Alzak aluminum reflector.** Wide beam for short range. Narrow beam for long range or spotlight.

**Gasket** of oil and gasoline resisting material furnished if needed.

Write for additional information.

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# New Literature

▲ "Industrial Electric Furnaces" — Volume I, by V. Paschkis, surveys the role of electric furnaces in processes of the metal, ceramic, chemical and other industries. It attempts to put electric heating upon a more rational basis and to bring design to more exact methods. Principles of design are discussed in detail and many types of practical furnaces are diagrammed. Formulae and curves are included which should prove useful to designers.

This first volume covers the thermal, electric and economic principles of all types of furnaces and appliances, and discusses arc furnaces and electrode melting furnaces, with emphasis on steel-melting furnaces but with a separate section on ferro-alloy furnaces.

The book will be helpful to the furnace operator who wants to increase his understanding of his equipment, as well as to the designer and the power engineer. Published by Interscience Publishers, Inc., New York, N. Y., 232 pages, $4.90.

▲ Something new and interesting about the George Washington family has been uncovered and detailed, in the new book "Principio to Wheeling — 1715-1945," by Earl Chapin May.

Few of the millions of American patriots to whom George Washington personifies this country, have had more than a vague idea that George Washington's father (Augustine) and his half brother (Lawrence) and their descendents were pioneers in developing our immense modern iron and steel industry.

Mr. May tells this unusual story in the first ten chapters of Principio to Wheeling, (Harper and Brothers). George Washington's father and half brother were iron ore miners and blast furnace operators in Colonial Virginia and Maryland. George was the explorer who led later iron makers into what is now West Virginia where they built the modern steel center of Wheeling.

Both professional and amateur historians will be grateful to Mr. May for locating a valuable vein of historical ore by discovering and digging into heretofore unknown, original documents, some of which are here reproduced. The book's story covers the period from 1715 to 1945 and dramatizes the nation's history through the story of Principio Furnace, Maryland, and how it became today's Wheeling Steel Corporation.

Added to a fascinating amount of historical and technical information are background chapters which amount to a biography of Wheeling during its many colorful years as a frontier river town. Here are new facts for the saga of the family of Washington as iron masters and a history of the American iron and steel industry. Here is a biography of a frontier city and the tale of one of the nation's great steel companies whose energies are today directed to turning out enormous quantities of essential munitions of war.

▲ A folder issued by National Carbon Company, Inc., contains an excerpt from Special Report No. 30 of the Iron and Steel Institute, London, England, dealing with "Blast Furnace Refractories . . . Carbon Bricks." This excerpt should be of interest to many blast furnace operators in this country. Copies are available upon request to the company at 30 East 42nd Street, New York, New York.

If you are interested in the use of carbon brick as outlined, our representatives will be glad to call upon you to discuss this subject.

▲ The Automatic Transportation Company, Division of The Yale and Towne Manufacturing Company, manufacturers of electric propelled industrial trucks, has just published a new six-page folder covering the "Transporter," battery powered hand lift truck.

The folder consists of detailed specifications and photographs covering both the pallet and platform type Transporter. The fork type lift truck for use with open faced or double faced pallets, and the platform type lift truck for skid transportation.

This condensed folder will be useful to manufacturers and in all lines of business. Copies will be sent upon request addressed to Automatic Transportation Company, 101 West 87th Street, Chicago 20, Illinois.

▲ A completely new, revised catalog has just been issued by Merco Nordstrom Valve Company. Comprised of 134 pages of valve listings and specifications, engineering tables, lubricant data, etc., it presents the latest information regarding the entire line of Nordstrom valves, and makes obsolete all previous editions of catalogs and bulletins.

Numerous revisions were made in the specification tables. Certain sizes and types, which previously overlapped other sizes, have been eliminated so that the new catalog presents a more streamlined arrangement of valves in keeping with the government's desire to avoid duplication of products and to provide greater simplification in cataloging.

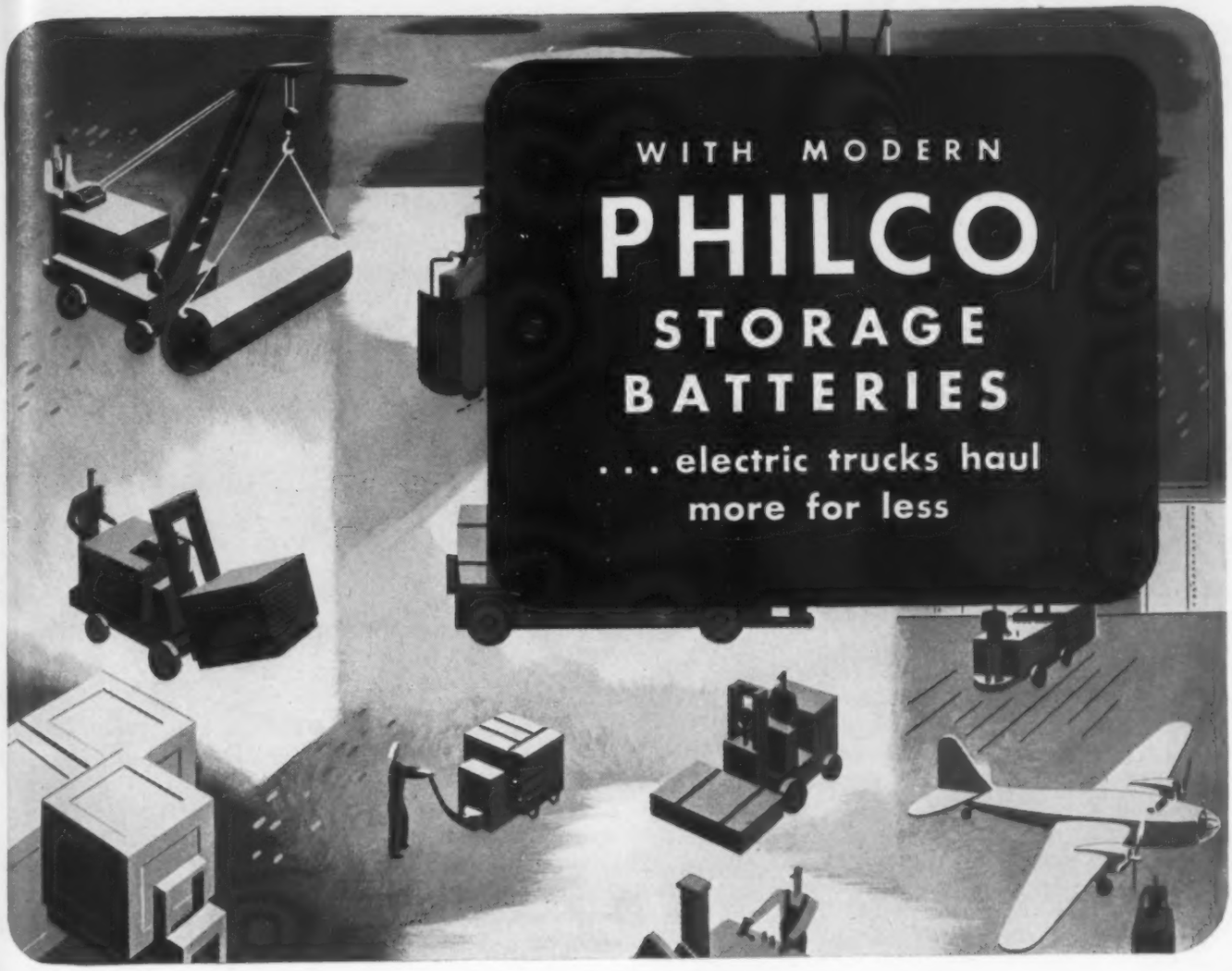
Many new and useful engineering tables have been added. Parts for the various types of valves are illustrated; also detailed drawings clearly depicting the features of construction. The latest listing of Nordco lubricants includes several new numbers.

A copy of the catalog, No. 9, may be obtained by valve users from Merco Nordstrom Valve Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania.

▲ An instructive manual designed to guide users of Nordstrom valves in the proper methods and routine of lubricating plus valves has been issued by Merco Nordstrom Valve Company. The bulletin illustrates each type of valve, revealing the operation and gives plain, specific directions how to lubricate, when, and the type of lubricant best suited for specific services. Twenty-four groups of valve parts are illustrated so that the user may select replacements. Grease gun lubrication is also discussed. The bulletin will serve as a convenient reference for servicemen, plant operators and others responsible for efficient valve operation. A copy of the bulletin, V-126, may be obtained from Merco Nordstrom Valve Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania.

▲ A new and attractive four-page folder recently issued by the Eutectic Welding Alloys Company provides a complete answer to the question "What are Eutectic low-temperature welding alloys?" in simple, understandable terms, and explains why EutecRods and EutecTrodes are rapidly becoming preferred alloys in the production welding field.

Among the outstanding features claimed for the rods are: Unusually low bonding temperatures that prevent distortion; less preheating of

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parent metal required; less after machining and cleaning; establishes a greater strength than brazing, with less rejects; and, insures a greater all around economy during use.

Specific applications, uses, and specifications on design and procedure of the various rods are also featured. A full-page assortment chart designed to aid engineers, technicians and welders in selecting the proper rod for their particular job is included.

Copies of this bulletin can be secured by writing directly to Department A-1, Eutectic Welding Alloys Company, 40 Worth Street, New York 13, New York.

▲ M. L. Bayard and Company announces a new manual describing in detail standard related units of a remote mechanical control system of new design.

Specification and capacity charts are given for the universal shaft assembly, steady shaft assembly, and bevel gear assemblies. In addition, are details on layouts for the most effective arrangement of these standard integrated units for such uses as to open or close large valves, ventilators, banks of windows, furnace doors, or in conjunction with such equipment as cranes, windlasses, winches and steering gear.

A copy of Bulletin A-100 will be sent upon request to M. L. Bayard and Company, 1934 Indiana Avenue, Philadelphia 32, Pennsylvania.

▲ Just off the press is a new folder "Five Insulating Brick Of Prime Importance to Refractories Users" published by Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania. The bulletin gives specific data and descriptive information in a form which is particularly valuable in reference work.

In the development of insulating fire brick the problem has invariably been that of achieving a proper balance between the interrelated properties of strength and thermal efficiency. In these Harbison-Walker products, light weight (essential to high insulating value and to low heat storage capacity) has been attained without sacrifice of the mechanical strength necessary to insure minimum loss through breakage in transit and in normal handling.

Copies of this folder may be had upon request to Harbison-Walker Refractories Company, Farmers Bank Building, Pittsburgh 22, Pennsylvania.

▲ A comprehensive picture story of the fabrication and erection of gas holders, storage tanks, processing vessels, and other structures is contained in general bulletin G-45 of the Stacey Brothers Gas Construction Company, Cincinnati, Ohio — one of the Dresser Industries.

Available on request, the 44-page bulletin shows the company's production and erection facilities in action, and illustrates in detail many of the products such as gas holders, storage tanks, and processing equipment which Stacey Brothers builds for the gas, petroleum, chemical and food industries.

▲ The new power plant recently installed by the Richfield Oil Corporation's Watson, California, plant is described in Cochrane reprint No. 38, and is an illustration of what modern equipment can do to bring about boiler efficiency of 83 per cent. Copies are available upon request to Cochrane Corporation, 17th Street, Philadelphia 32, Pennsylvania.

▲ The Metal and Thermit Corporation, New York, New York, announces the publication of a 32-page illustrated booklet describing fabrication and repair by Thermit welding. The process is explained in detail and there are a series of four-color charts which illustrate in cross-section the forming of a Thermit weld.

The booklet contains a fund of information relating to general fabrication, repairs to heavy equipment, such as crankshafts, axles, cylinders and housings; rail welding for steam and street railways, coal mine track, and crane railways. Thermit welding in marine work is described, including the fabrication of stern frames, and the repair of heavy parts.

▲ A new 4-page folder on Rex Z-Metal chain belts is being distributed by the Chain Belt Company of Milwaukee. The bulletin gives interesting and practical information regarding Z-Metal chain belts and their application. One of the factors claimed for this type casting is its remarkable resistance to corrosion due to the patented process of manufacture. Some of the more popular type chains, available in Z-Metal are illustrated. For copies, request bulletin No. 460 from the Chain Belt Company, Milwaukee 4, Wisconsin.

▲ Describing many applications with pictures and text, a new broadside on the Punch-Lok safety clamps used in the newest method of banding hose or splicing cable has been published by The B. F. Goodrich Company, Akron, Ohio. Copies can be obtained upon request. The clamps are available in two types, the pre-formed, complete rings which are shaped to slip over the ends of hose, nipples, connections, or other sections to be joined and the open-end, straight bands made to permit curving around hose, cable or other objects that need binding.

The broadside describes the safety and time-saving features of the clamps, now being distributed nationally by the industrial products sales division of B. F. Goodrich.

▲ The Vanadium Corporation of America is resuming publication of their house organ, The Vancoram Review, which will be issued quarterly and is being presented in an entirely new and attractive form.

With the new issue, the Vanadium Corporation dedicates the publication as a "practical, impartial aid to the continued advancement and progress of alloys, metals, and allied chemical compounds."

Articles in the current issue cover applications of vanadium in the aircraft, railroad equipment and cast steel industries; a new graphizing alloy for cast iron; and use of Grainal alloys for improvement of NE specification steels, and in making anchor chains. Special departments are devoted to new products, and abstracts of current literature. Principal products of the Vanadium Corporation and their applications are also listed.

The Vancoram Review is an informative bulletin for those who are interested in the development and application of ferro-alloys, metals, in general, and allied chemical compounds.

▲ The 4 page folder published by the A. F. Holden Company, New Haven, Connecticut, shows the standard types of electric electrode furnaces which have been built for operations such as annealing of brass shell cases, heat treatment of tool steels, high speed steels and production steels, either SAE or NE. The bulletin gives line drawings showing construction of four types of furnaces and indicates the simplicity of operation. Copies of the bulletin are available upon request.

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The Hyatt Bearings in this application have the capacity and stamina to withstand the strains and jolts of frequent starts and stops. They also provide the distinct engineering advantage of inner race seats that remain as fixed parts of the shaft which are never disturbed by having to be removed.

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# Personnel News

**John L. Young** has been elected to the newly created post of vice president in charge of engineering of United States Steel's National Tube Company. Mr. Young has been vice president in charge of industrial research and development of the United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

A native of Evansville, Indiana, and a graduate of the University of Indiana, Mr. Young began his career with the Timken Roller Bearing Company in Canton, Ohio. There he held various positions in the alloy tube and steel departments, later transferring to the metallurgical department working on operating problems from a metallurgical standpoint.

In 1930, he came to Pittsburgh for the same company as a development engineer to study the application of bearings in steel mill machinery, and later returned to Canton and became assistant general manager of Timken's industrial division.

Mr. Young joined the United Engineering and Foundry Company in 1936. He was responsible for the development of machinery and equipment for the steel and allied industries. In 1941, he was loaned as project manager to design and construct the Defense Plant Corporation's aluminum rolling mills at Trentwood, Washington.

**Harry O. Bercher,** former head of the production planning department at Wisconsin Steel Works, International Harvester Company, has been appointed assistant to the vice president, Steel Division.

**Leslie G. Graper,** formerly of the open hearth department, Wisconsin Steel Works, and for the past year and a half or more in the production planning department, Chicago Office, is appointed head of this department in place of **Mr. Bercher.**

Other personnel changes announced at Wisconsin Steel Works are:

**Roy A. Lindgren,** former superintendent, blast furnace department, to 2nd assistant general superintendent.

**Paul R. Nichols,** assistant superintendent, blast furnace department, was appointed superintendent of that department, succeeding **Mr. Lindgren.**

**Roy P. Wheatley** was made assistant superintendent of that department, succeeding **Mr. Nichols.**

**Benjamin F. Courtright** was appointed sales manager, Steel Division, in place of **O. F. Seidenbecker,** resigned. Mr. Courtright has been head of the metallurgical and inspection department of Wisconsin Steel Works, for the past twenty years.

**Frederick M. Washburn,** assistant superintendent, metallurgical and inspection department, was named superintendent of that department to fill the vacancy caused by **Mr. Courtright's** promotion.

**Earl W. Pierce** has been appointed chief metallurgist and **Tom J. Peters** as assistant to general superintendent at the South Chicago plant of Carnegie-Illinois Steel Corporation.

Mr. Pierce has been associated with the plant for the last 15 years. He started as a metallurgist in the plant laboratory. He goes to his new post after three years as assistant to general superintendent. He is a graduate of Ohio Wesleyan University and has a master's degree from Vanderbilt University.

Mr. Peters also has been with the South Chicago plant for the last 15 years. He started as a testing engineer in the electrical department and since has advanced through various positions to his most recent, assistant superintendent of the maintenance division. He was educated at Carnegie Institute of Technology, Armour Institute and Westinghouse Tech at East Pittsburgh, Pennsylvania.

**Tracy V. Buckwalter,** who for the past twenty-five years has served as chief engineer and vice president of the Timken Roller Bearing Company, retired April 30 under the company's retirement annuity plan. The

TOM J. PETERS

EARL W. PIERCE

JOHN L. YOUNG

ARE YOU USING THE TUBING *best* SUITED FOR YOUR JOB?

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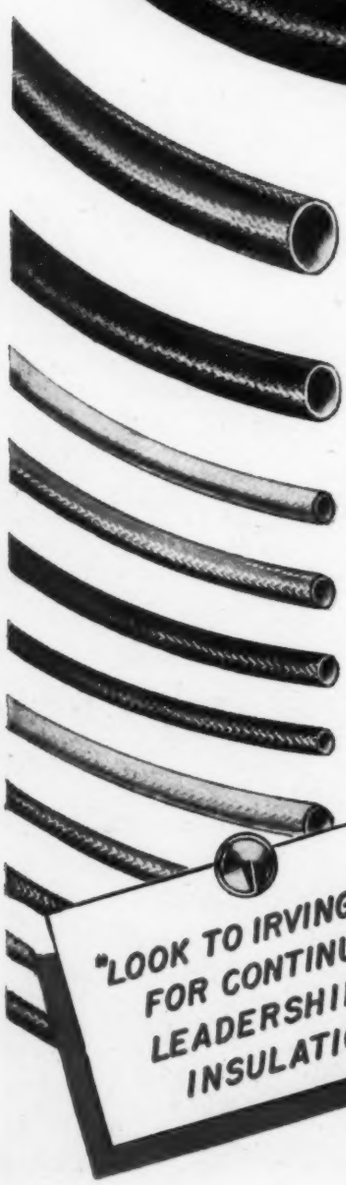


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Slot Insulations

Harvel and Irvington Insulating Varnishes

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**VARNISH & INSULATOR COMPANY**

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company will, however, retain his services in a consulting capacity.

Mr. Buckwalter came with the Timken Company in 1916 as chief engineer after sixteen years with the Pennsylvania Railroad Company in their shops in Altoona, Pennsylvania.

For many years his work with the Timken Company as chief engineer embodied engineering and development in the automotive and general industrial fields, outstanding among which was the development of large bearings and their application to ferrous and non-ferrous rolling mills.

Mr. Buckwalter was elected vice president of the company in 1925 and thereafter a large part of his time was given to the development of the company's railroad activity. Under his direction large fatigue testing machinery was developed and located in the Timken laboratories in Canton.

S. B. HEPPENSTALL, JR.

**S. B. Heppenstall, Jr.,** has been elected vice president of H. K. Porter Company, Inc. He will make his headquarters in the general offices of the Porter Company in Pittsburgh, Pennsylvania.

Mr. Heppenstall was formerly vice president in charge of sales in the Heppenstall Company. He is a member of the Association of Iron and Steel Engineers and the American Iron and Steel Institute.

**Clark H. Johnson,** formerly superintendent of the New Castle (Pennsylvania) plant of United Engineering and Foundry Company, has been transferred to the Pittsburgh office staff, due to increased activity in connection with domestic and foreign sales. To fill the vacancy left by Mr. Johnson, **Howard B. Cummings** has been made superintendent of the New Castle plant.

**William Hagel,** vice president and manager of machinery sales for United Engineering and Foundry Company, has been appointed a vice president of the Adamson-United Company of Akron, Ohio.

**J. R. Guth** has been appointed to the position of director of purchases for the Tyson Bearing Corporation, at Massillon, Ohio. Before joining the Tyson Corporation a year ago as assistant sales manager in the Aircraft division, Mr. Guth was with Goodyear Aircraft.


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J. J. HUETHER

**J. J. Huether** has been made assistant manager of the industrial divisions, and **W. A. Wirene,** manager of the industrial materials division of General Electric Company. Mr. Huether had been manager of the industrial materials division for eight years, with Mr. Wirene as assistant manager since 1942.

Mr. Huether was born at Sharon, Pennsylvania, and is a graduate of Notre Dame University with the class of 1922. He joined General Electric at Schenectady as a student engineer. He became associated with the industrial department in 1924 as a member of the steel mill section, remaining after its combination with the mining section until 1931, when he was appointed manager of sales, machinery manufacturers section. In April, 1937, he became manager of the mining and steel mill section, later renamed industrial materials division.

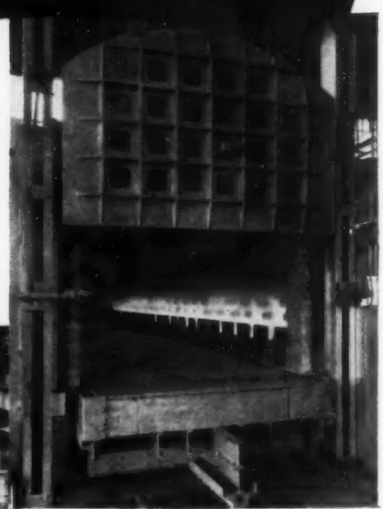
A native of Columbia, Iowa, Mr. Wirene was graduated from Iowa State College in 1925 with a bachelor of science degree in electrical engineering. In August of that year he entered the employ of General Electric as a student engineer. In 1926 he became a member of the sales training course, and was later transferred to the industrial department.

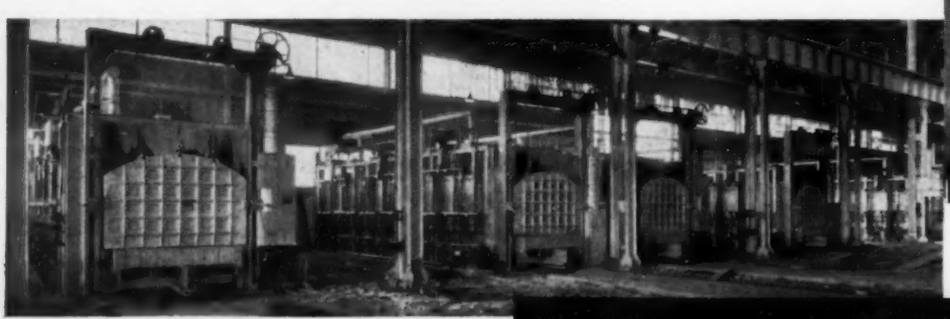
W. A. WIRENE


P.I.E. *Car-Type* HEAT TREATING FURNACES

In the production of forgings, rods, bars and rod coils, P.I.E. Car-Type Heat Treating Furnaces prove outstanding in their advantages. They have simple controls and are easy to operate. Because of patented RADI-FLECTO Burners, controlled atmosphere is obtained with faster, more uniform heating and decreased fuel and maintenance costs.

*Ask for further information.*





*Above—Internal view of furnace in battery of P. I. E. Car-Type Heat Treating Furnaces shown at left.*

*For full information on AMCO Recuperative Pit Furnaces, Open Hearth Furnaces and Large Recuperative Rotating Hearth Furnaces, write to AMSLER-MORTON DIVISION of Union Industries, Inc., Fulton Building, Pittsburgh 22, Pennsylvania.*

P-2

PENNSYLVANIA INDUSTRIAL ENGINEERS

*Division of Union Industries, Inc.*

FULTON BUILDING PITTSBURGH 22, PENNA.

Early in 1927 Mr. Wirene became a salesman's assistant in the industrial department of the company's Chicago office, and later that year was named a salesman in the Kansas City, Missouri, office. In 1940 he returned to Schenectady as sales engineer of the petroleum and chemical section of the industrial department, and in January 1942 was appointed assistant manager of the petroleum, chemical, mining and steel mill section, which later became known as the industrial materials division.

**A. F. Metz** has been elected vice president of The Okonite Company and The Okonite-Callender Cable Company, Inc., and a member of both executive committees. Mr. Metz, who was also reelected treasurer of both companies has been a director of The Okonite Company since 1928 and of The Okonite-Callender Cable Company, Inc. since 1941. At the same time **E. J. Garrigan** was elected a director of both companies and, in addition, reappointed vice president and factory sales manager. **A. L. McNeill,** who was recently appointed district manager of the companies' Chicago territory, was also elected as a vice president of both companies.

**J. E. N. Hume,** commercial vice president and manager of the industrial divisions, and **J. W. Belanger,** manager of the federal and marine divisions of General Electric Company, have been named assistant managers of sales of the apparatus department.

**Karl H. Runkle** has been named manager of General Electric's industrial divisions to succeed Mr. Hume, and **R. S. Neblett** has been named federal and marine divisions manager to succeed Mr. Belanger.

**W. V. O'Brien** has been appointed manager of the central station divisions for General Electric Company, succeeding **H. V. Erben,** who recently was named assistant general manager of the apparatus department.

Mr. Hume has been manager of the industrial divisions since 1935. A native of Virginia, he was graduated from the University of Virginia in 1906 and entered the employ of General Electric the following January. He was named a commercial vice president December 30, 1938.

Mr. Belanger has been manager of the federal and marine divisions since January, 1943. A native of New Bedford, Massachusetts, he entered General Electric's "test" at Lynn in 1917. He had studied electrical engineering in a night course at Franklin Institute in Boston.

Mr. Runkle, a native of Iowa, has been with General Electric since his graduation from Iowa State College in 1917. Since 1936 he has been an assistant manager of the industrial divisions.

Mr. Neblett, a native of Texas, joined General Electric in 1923 the year he graduated from Georgia Tech. He has been assistant manager of the turbine division since 1939 and since 1943 has acted as assistant manager of the federal and marine divisions.

Mr. O'Brien was born in Point Pleasant, West Virginia, and entered the employ of General Electric in 1922, the year he graduated from the Virginia Military Institute. He has been assistant manager of the central station divisions since January of this year. For the five years previous he was manager of the wire and cable division.

**Centuries ago, when potential besiegers lurked in every forest glade, castles were prepared to withstand violent assault in the event that the outer works were penetrated. A secondary "point d'appui" or strong point, had to be in readiness. Thus each fortress had a Donjon—a huge square tower defying current methods of attack. Secure as Donjons were from without, they were weak from within; the summer heat was torrid, the winter cold severe, and sanitary and living conditions were unbearable. Surrender oftentimes was the wiser choice.**

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*Mr. Harry Dobrin, well-known consultant on combustion problems, is now vice president of Furnace Engineers, Inc.*

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NEW PRINCIPLES OF DESIGN
*Low in Cost · High in Efficiency*
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FRED J. RYAN COMPANY
WYNCOTE, PENNA., U.S.A.


**Robert E. Cramer** has been named chief engineer of the American Steel & Wire Company, United States Steel Corporation subsidiary, succeeding **E. J. Reardon**, who recently resigned.

Mr. Cramer's thirty-five year association with U. S. Steel subsidiaries began in 1910, when he was employed as a blue print boy at the Schoenberger works of the American Steel and Wire Company at Pittsburgh, Pennsylvania. Several years later, he was transferred to the Carnegie Steel Company as a draftsman, returning to the Schoenberger works in February, 1916, as assistant steam engineer in the district steam engineering department. He successively was made district engineer at the Pittsburgh office of the Wire Company and superintendent of engineering and maintenance at the Donora (Pennsylvania) Steel and Wire Works, before being transferred to the Cleveland office in September, 1941, as a special engineer in the engineering department. In March, 1942, he assumed the position of engineer of appropriations and properties which position he now relinquishes to become chief engineer.

**David E. Jenkins, Jr.,** has been appointed assistant manager of sales of Tate-Jones and Company, Inc., manufacturers of industrial furnaces and heat treating equipment.

**Earl H. Fyler,** assistant superintendent of industrial relations at the Gary, Indiana, works of Carnegie-Illinois Steel Corporation since November 1, 1940, has been promoted to the position of assistant to director of industrial relations for the entire Chicago district. He is a Dartmouth graduate and a native of Burke, Vermont. He started his association with the company in 1930 as a sales student.

**Arthur H. Kofoed** has been promoted to succeed Mr. Fyler at Gary steel works. He has been with the company since 1936. Since July 1, 1943 he has been serving as assistant superintendent of industrial relations, assigned to the armor plate division at Gary. He received his A.B. degree at Carthage College.

**John E. Ponkow,** formerly chief electrical engineer and supervisor of experimental engineering for the Federal Machine and Welder Company of Warren, Ohio, has been appointed sales manager of the company. Mr. Ponkow, who is a graduate of Johns Hopkins, with a B.E. degree was formerly with Westinghouse, where he was engaged in power design on d-c rotating equipment, and later in general industrial design, in both the Pittsburgh and East Pittsburgh plants. He joined Federal in 1941, as assistant chief electrical engineer and became chief in 1943.

**Tom M. Girdler** has resigned as chairman of the board of Consolidated Vultee Aircraft Corporation after almost three and one-half years of service during which the company has become one of the world's largest aircraft producers.

Mr. Girdler, who continues as chairman of the board of Republic Steel Corporation, the nation's third largest steel producer, became chairman of the Consolidated and Vultee corporations in December, 1941, to help accelerate military aircraft production.

(*Please turn to page 130*)

# Heavy Loads and Violent Surges Demand SA45's and AX5's

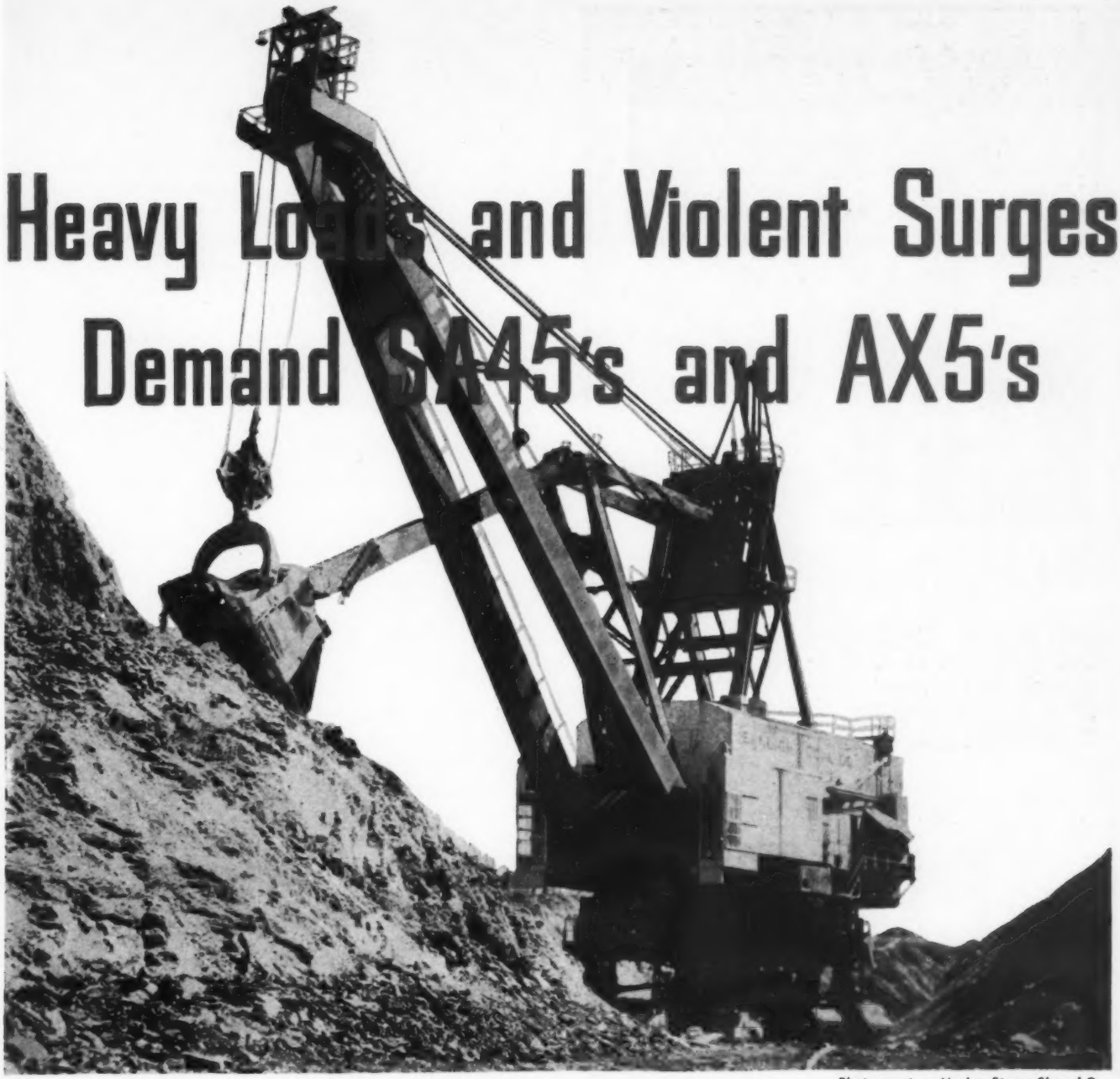

*Photo courtesy Marion Steam Shovel Co.*

CARBON brushes that are tough mechanically, and tough electrically, are necessary to keep giant 35-cubic-yard electric coal strippers working smoothly, efficiently.

"National" Grade SA45 brushes for the generators and Grade AX5 brushes for the motors are helping many of these giants maintain splendid performance records even in the face of extremely heavy loads, repeated current surges and continuous operation.

Grade SA45 brushes were developed for use where commutating conditions are especially severe, as on electric shovel generators and other D.C. generators, motors and rotaries requiring high commutating ability. The heavy-duty Grade AX5's are outstanding brushes for D.C. shovel motors, as well as for all classes of traction, mine and mill motors.

The long research and the manufacturing experience that have so well fitted these brushes to their jobs have also enabled National Carbon to develop brushes of high performance and efficiency ratings for all kinds and sizes of rotating electrical equipment . . . for any duty!

Whatever your brush problems may be, you are invited to call on our nearest Division Office for assistance.

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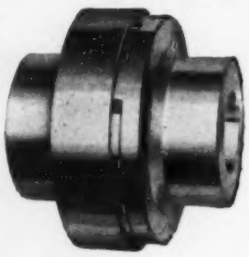
With resilient free-floating load cushions of material suited to each particular duty — suspended between rugged metal jaws — cushions are free to adjust for every emergency. To correct for misalignment — take up shock, vibration, surge and overload — to transmit full power flow smoothly — to protect equipment and prolong its life.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Set comes with L-R Catalog. Leads the finger to exact couplings required, without tedious figuring. Weights, sizes, all engineering data with prices right at hand. Catalog lists and describes couplings for every kind of duty. 1/6 to 2500 h.p. at 100 r.p.m.

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**Carl A. Salmonsen,** assistant manager of the General Electric's River Works at Lynn, Massachusetts, has been named manager of the company's Philadelphia Works, effective May 1, and **Robert Paxton,** Philadelphia Works manager, has been named manager of the G-E Pittsfield (Massachusetts) Works, effective July 1, at which time **L. E. Underwood** will retire as manager there. From May 1 until July 1, Mr. Paxton will be assistant manager of the Pittsfield Works.

**John J. Heffernan** has been appointed purchasing agent of the Universal Atlas Cement company and the Atlas Lumnite Cement Company, United States Steel Corporation subsidiaries. He succeeds the late **Richard B. Hynes** who died on March 21. Formerly secretary of Universal Atlas and of Atlas Lumnite, Mr. Heffernan has served for the past two years as assistant purchasing agent of both companies.

After active service during the first World War Mr. Heffernan was employed in various capacities in New York and Boston. In 1925 he joined the Atlas Portland Cement Company, New York, where he was employed in the secretary's office. When Atlas and Universal were combined in 1930 with headquarters in Chicago, Mr. Heffernan transferred and subsequently became assistant secretary of Universal Atlas and of Atlas Lumnite in Chicago. Later he became secretary and then assistant purchasing agent of both companies in New York.

**R. S. Quinn,** general superintendent of Mingo Works, Carnegie-Illinois Steel Corporation, retired April 1 after 56 years of continuous service at this U. S. Steel plant. First employed at Mingo Works as a nailer's helper in 1889, Mr. Quinn worked at this and other jobs on week-ends and vacations while still attending school. After graduation from high school in 1894, he became an apprentice in the plant's machine shop, and was made acting machine shop foreman five years later.

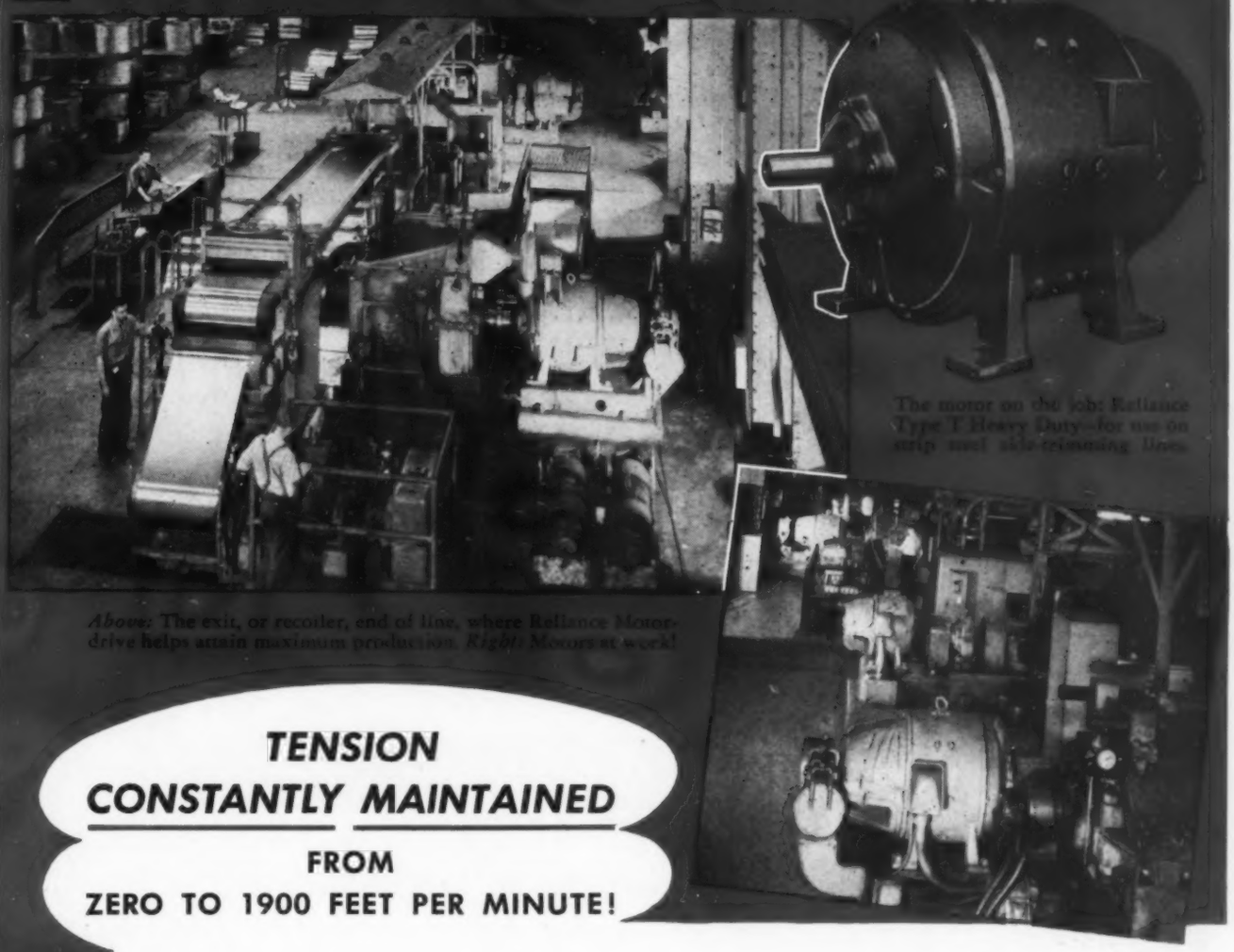
After becoming master mechanic in 1911, he was made assistant general superintendent in 1927 and was appointed general superintendent in 1933.

Concurrently with Mr. Quinn's retirement, the management of Mingo Works will come under the direction of the company's Homestead Steel Works, and will be known as the Mingo Plant of Homestead Steel Works. Administration of both operations will be the responsibility of **H. G. McIlvried,** general superintendent at Homestead.

## *Obituary*

**Robert I. Gumaer,** combustion engineer for Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania, died of a heart attack April 29. Mr. Gumaer was born in Kingston, New York. He attended the Carnegie Institute of Technology and graduated in 1925. For a short time he worked for United States Steel Corporation in its Clairton works. In 1927 Mr. Gumaer was employed by the Jones and Laughlin Steel Corporation as a combustion engineer in their Aliquippa Works and has served in that capacity to the time of his death. He was the author of a number of technical papers and participated actively in various engineering meetings.

"MOTOR DRIVE IS MORE THAN POWER"



*Above:* The exit, or recoiler, end of line, where Reliance Motor-drive helps attain maximum production. *Right:* Motors at work!

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### FROM ZERO TO 1900 FEET PER MINUTE!

In this variable-voltage side-trimming line, Reliance Motor-drive provides a full range of linear speeds, from low threading and inspection speeds to a maximum production speed of 1900 feet per minute. Control is from a centralized operator's station.

Tension is maintained at a constant rate throughout all speed changes by means of variable-voltage control sets. These include booster generators which compensate for IR drop and correct for inertia differences during acceleration and deceleration.

This type of all-electric control, obtained through the use of Reliance Motor-drive can produce greatly improved results in both quantity and quality of output. Complete information on this and other interesting Reliance steel mill applications is yours for the asking. Just call the Reliance office near you, or write the factory.

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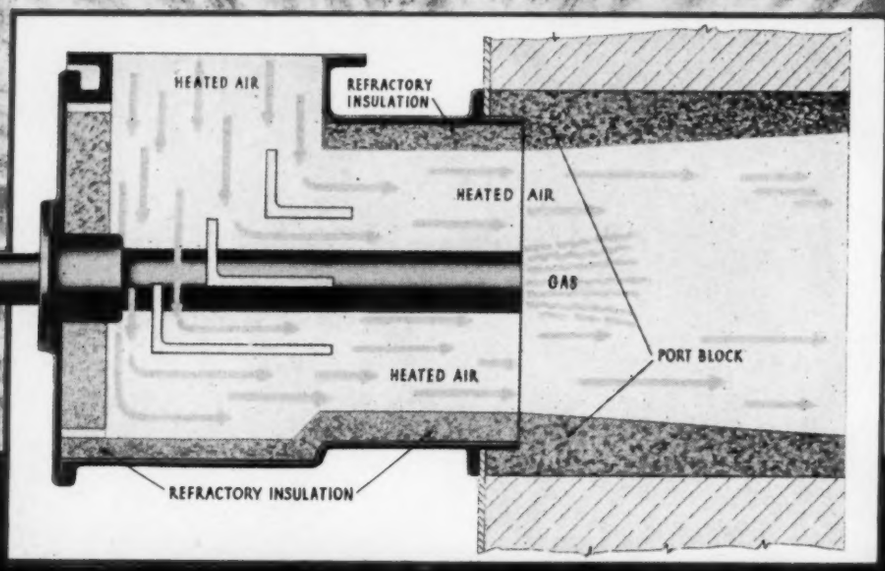
# RELIANCE A·C D·C MOTORS

# The outstanding burner for high temperature furnaces

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**for use with combustion air preheated to 600° F to 1500° F**

You get maximum operating efficiency—without excessive flame temperature—by using the Bloom Hot Air Burner with preheated air (600°F to 1500°F) for natural, coke oven or mixed gas, or oil or tar fuel.

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The **Quick-As-Wink** design incorporates simplicity, trouble-free service, and ease of application.

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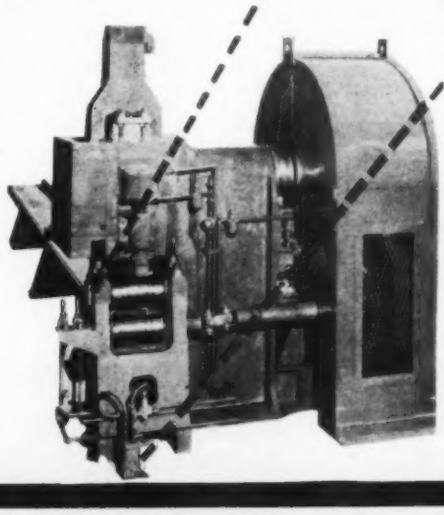
C. B. Hunt & Son manufactures solenoid, hydraulic, air, hand, foot, and diaphragm operated valves for air, water, or oil applications up to pressures of 5,000 pounds, in standard and special sizes.

**The Hunt catalog carries *complete* engineering data. Send for a copy.**



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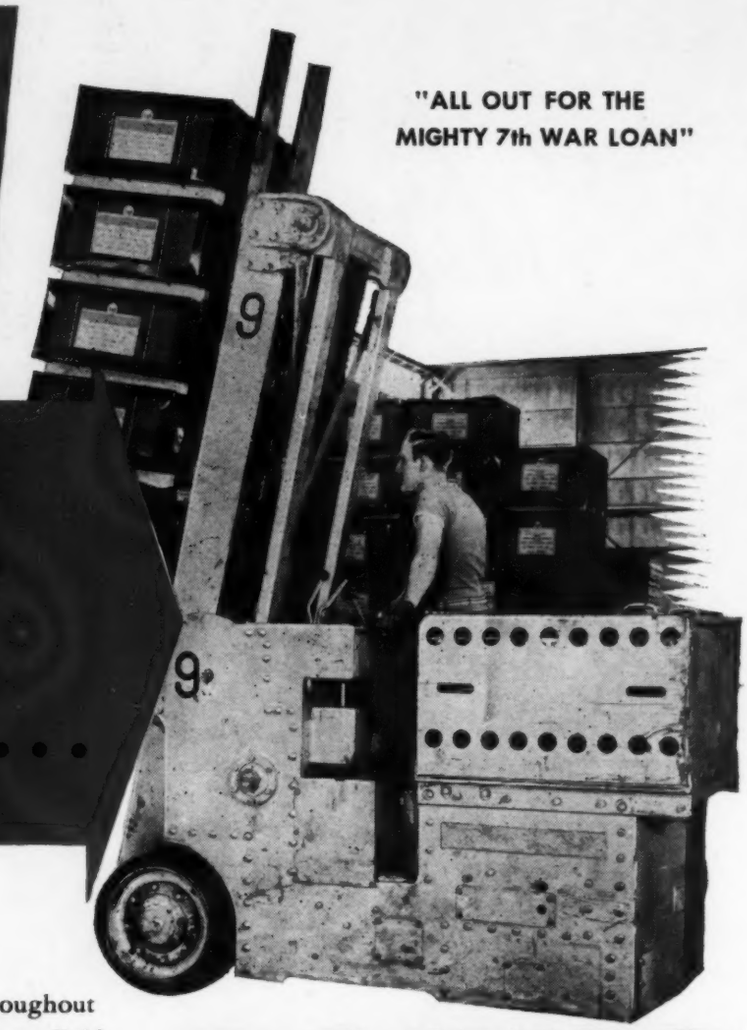
# EXIDE POWER

## KEEPS TRUCKS HUSTLING IN TOP FORM ALL DAY LONG . . . . .

"ALL OUT FOR THE MIGHTY 7th WAR LOAN"



Sustained speeds are kept up throughout the day when electric industrial trucks are Exide-powered. They wind in and out along the warehouse highways—lifting, hauling and stacking unit loads—at savings of time and manpower, at lowered costs, and with improved efficiency.

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Write us for a FREE copy of the bulletin "Unit Loads," prepared by The Electric Industrial Truck Association. It tells how to cut handling costs up to 50% . . . covers latest developments in materials handling . . . and includes actual case histories.

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THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32

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Is this your Motor Performance Chart?

NEW MOTOR

AFTER LONG AND CONTINUOUS SERVICE

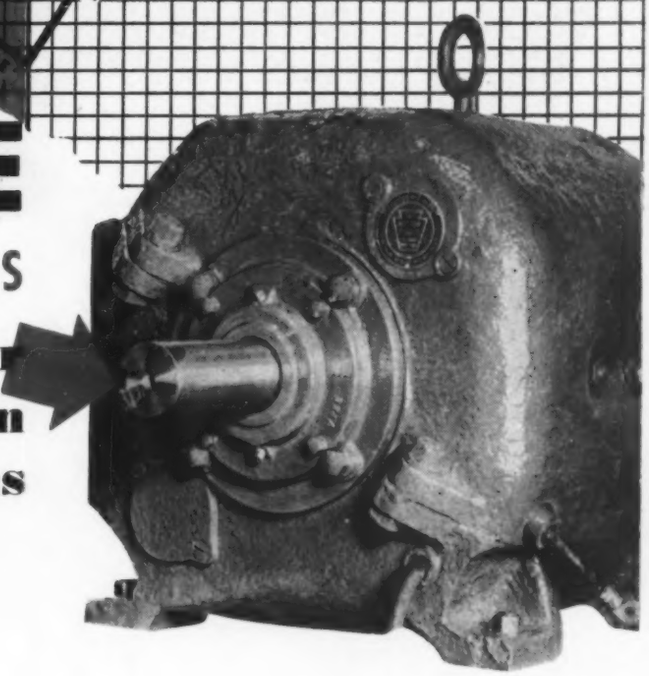
It can easily be this!

INSTALLATION OF KEYSTONE END BELLS

# KEYSTONE

## BALL BEARING END BELLS

## ....Are Answering Motor Maintenance Problems on Thousands of Installations



The ability of the grease-packed, KEYSTONE BALL BEARING END BELL to solve the most difficult of all motor maintenance problems—dirt and oil on the commutator—is just one reason why this conversion is economical, practical and many times a necessity.

Increased production due to less motor breakdowns—fewer manpower hours spent in servicing motors are two more points to consider. Other factors, fully important in maintenance problems, can be quickly overcome by the KEYSTONE END BELL.

Years of experience in designing END BELLS for industrial application shows that no other solution to motor maintenance problems is so completely effective, so quickly apparent.

The motor illustrated is one that has had wide use in every industry. Hundreds of these motors in all sizes have been converted to KEYSTONE END BELLS with outstanding success. These motors equipped with KEYSTONE END BELLS now run months with only occasional maintenance inspection. Breakdowns due to oil and dirt have been eliminated.

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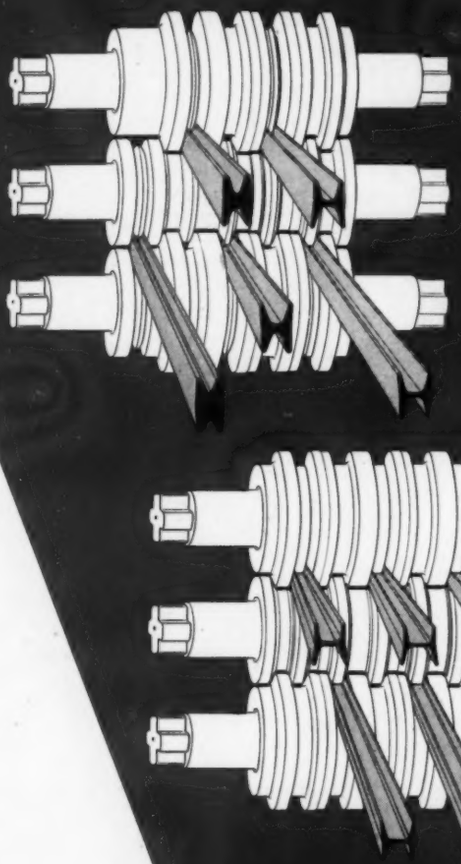
# ROLLING TECHNIQUE . . .

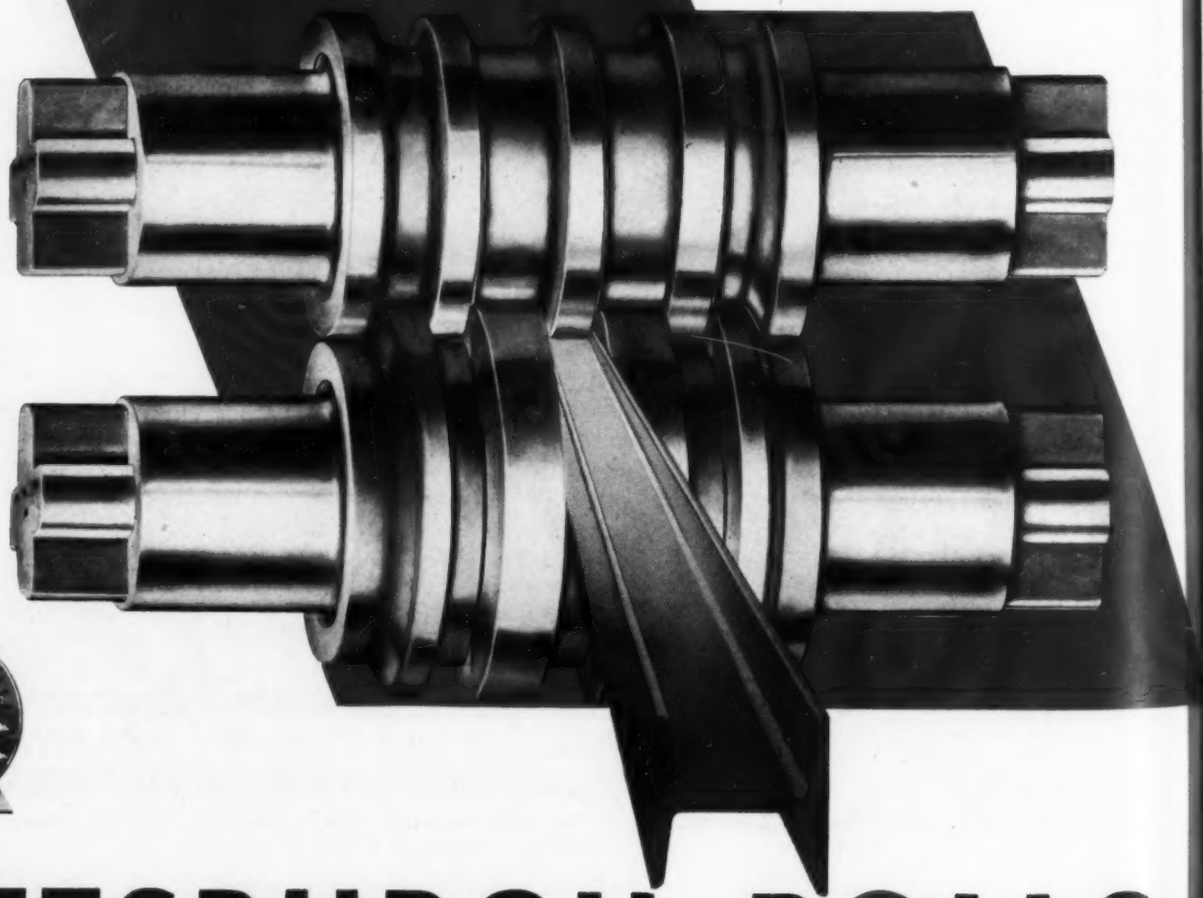
# "H" Beams



Modern high speed rolling mill production on "H" beams and other structural shapes is the result of improvements in automatic controls, instrument applications, and other refinements. But the rolls are still the heart of the mill.

Pittsburgh rolls, with three-quarters of a century of roll-making experience and satisfactory performance behind them, can be relied on to deliver the production for which high speed modern mills are designed at less cost per ton of steel rolled.

**PITTSBURGH ROLLS**
**Division of Blaw-Knox Company**
PITTSBURGH, PA.



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1870
1945

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*Better lubrication at Less Cost per Month*



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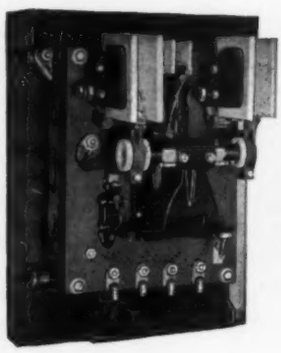
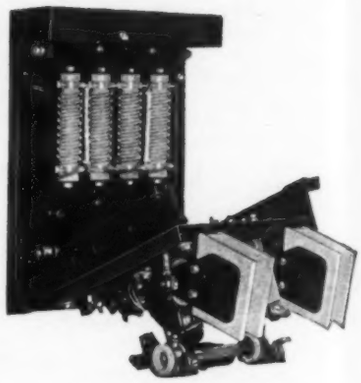
**With arc suppressor and quick drop, automatic for any class of material.**



Closed



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**Two main switches open circuit in series. Reverse and quick drop are automatic. Master contacts carry control circuits only.**

**The arc suppressor reduces the arc so it is not harmful or disagreeable. Contact tips are thus saved. Arc shields do not burn.**

**This controller makes possible 6 or more lifts per minute which is as fast operation as any we have ever observed in practice.**

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**The Ohio Electric Manufacturing Company**

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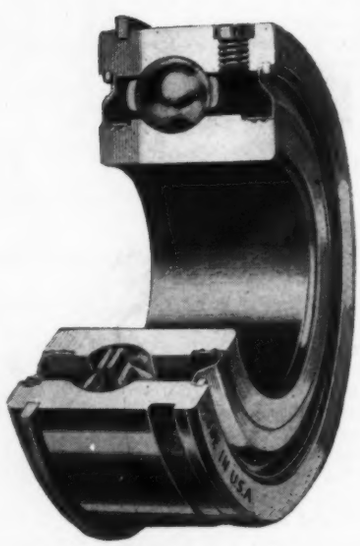
*It's as simple as that!*



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## *Triples output* of wire-rewinding lines

At this mill, each wire-rewinding line does the work of three, because Thy-mo-trol drive maintains constant and maximum winding speed throughout the winding operation. The rpm of the bobbin, or reel, motor is now automatically changed to allow for coil "build-up", and the wire travels at constant speed in the 1500 to 2000 rpm range.

Furthermore, because the tension is held uniform throughout the winding operation, more evenly wound coils are produced than when a mechanically controlled group drive was used. The reels can be unwound at high speed, without breakage.

### *OPERATES FROM A-C POWER*

Savings in floor space, in "down" time, and in maintenance cost also add to the gains of this installation—one job in the ever-widening range of Thy-mo-trol applications where stepless, closely controlled motor speed and torque are required (⅛ to 25 hp)—all operated from an a-c power supply.

Thy-mo-trol drive is a co-ordinated set of equipment, including d-c motor, electronic panel, transformer, and control station. G-E engineers will help you select and apply Thy-mo-trol drives to your machines, or explore their suitability for new functions. Ask for Bulletin GEA-4025. *General Electric Company, Schenectady 5, N. Y.*

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